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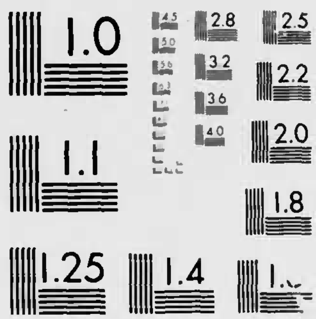
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FINAL REPORT

INSTALLATION RESTORATION PROGRAM PHASE II - CONFIRMATION/QUANTIFICATION STAGE 2 - BULK FUEL STORAGE AREA FUEL SPILL INVESTIGATION

AD-A191 022

FOR

McGUIRE AIR FORCE BASE, NEW JERSEY 08641

PREPARED BY:

Roy F. Weston, Inc.
West Chester, Pennsylvania 19380

OCTOBER 1987

Final Report for Period 8 February 1985 to 30 September 1987

Approved for Public Release; distribution is unlimited

PREPARED FOR:

HEADQUARTERS MILITARY AIR LIFT COMMAND-
COMMAND SURGEONS OFFICE (HQMAC/SGPB)
BIOENVIRONMENTAL ENGINEERING DIVISION
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UNITED STATES AIR FORCE
OCCUPATIONAL & ENVIRONMENTAL HEALTH LABORATORY (USAFOEHL)
BROOKS AIR FORCE BASE, TEXAS 78235-5501

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PHASE II - CONFIRMATION/QUANTIFICATION
STAGE 2 - BULK FUEL STORAGE AREA FUEL SPILL INVESTIGATION

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FOR
MCGUIRE AIR FORCE BASE, NEW JERSEY 08641

HEADQUARTERS MAC/SGBP
SCOTT AIR FORCE BASE, ILLINOIS 62225-5000

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PREFACE

The purpose of this report is to document the accomplishment of the Phase II Stage 2 Problem Confirmation Study of the United States Air Force Installation Restoration Program (IRP) at McGuire Air Force Base, Burlington County, New Jersey. This work was conducted by Roy F. Weston, Inc. (WESTON) under Contract No. F33615-84-D-4400, Task Order 3.

Mr. Peter J. Marks is Program Manager for this Contract. Ms. Katherine A. Sheedy managed this Task Order. Laboratory analyses were accomplished at WESTON's Laboratory in Lionville, Pennsylvania, under the supervision of Dr. Earl M. Hansen. Roy F. Weston, Inc. wishes to acknowledge Captain Richard Tourjee, Base Bioenvironmental Engineer, and Martin Eisenhart and Bill Flockhart of Base Civil Engineering for their assistance during the conduct of this project.

This work was accomplished during the period 8 February 1985 through 24 April 1985. Cpt. Maria R. LaMagna, USAF, BSC, Technical Services Division, USAF Occupational and Environmental Health Laboratory (USAFOEHL/TS) was the Technical Monitor.

Peter J. Marks
Program Manager

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EXECUTIVE SUMMARY

ES.1 INTRODUCTION

Roy F. Weston, Inc. (WESTON) has been retained by the United States Air Force Occupational and Environmental Health Laboratory (USAFOEHL) under Basic Ordering Agreement (BO) Contract No. F33615-84-D-4400 to provide general engineering, hydrogeological, and analytical services. By message dated 4 May 1984, McGAFB requested USAFOEHL assistance in analysis and remediation of a JP-4 spill that had occurred at the base. In response to this request by message dated 11 May 1984, USAFOEHL committed to provide assistance. WESTON was directed to proceed to McGAFB, to inspect the spill site, and to prepare a presurvey report for Air Force review and implementation.

McGAFB has identified the source of the spilled fuel as the lines associated with the now inactive railroad off-loading facility (see Figure ES-1). The leak was effectively stopped by permanently disconnecting these lines from the fuel system. Therefore, the following Technical Scope of Work deals only with the second and third aspects of a fuel spill evaluation. USAFOEHL issued Task Order 3 of this contract dated 20 July 1984 authorizing WESTON to perform an investigation at the base Bulk Fuel Storage Area.

As the primary parameters for evaluation of fuel migration and subsequent groundwater contamination, WESTON used the following analytes:

- U.S. EPA volatile organic and aromatic hydrocarbons that are components of JP-4:
  - Benzene,
  - Toluene, and
  - Xylenes (BTX).
- Oil and grease (O&G).

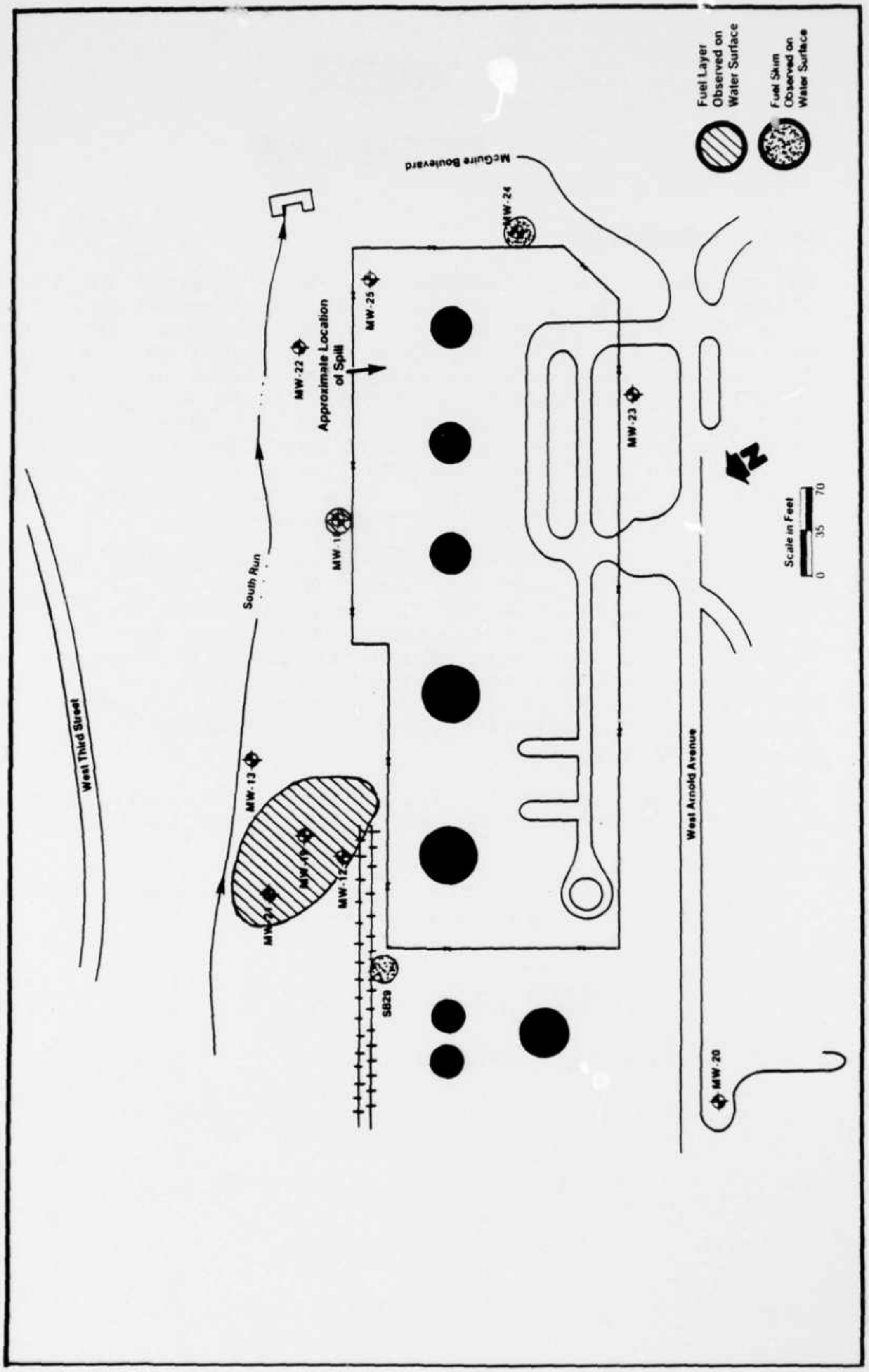

FIGURE ES-1 GENERAL SITE MAP OF THE BULK FUEL STORAGE AREA SHOWING FLOATING FUEL PRODUCT DISTRIBUTION MCGUIRE AFB, NEW JERSEY

5723A

WESTON completed 30 soil borings and installed 8 permanent groundwater monitor wells. Soils (16 surface soil samples and 44 soil boring samples) were analyzed for oil and grease (O&G). All water samples were analyzed for O&G and BTX. Sampling was accomplished in accordance with U.S. EPA standard protocols, and the analyses were performed using U.S. EPA Standard Methods 413.2 for O&G and 602 for BTX.

Two rounds of groundwater samples were collected: the first round on 2 April 1985 and the second round on 23 and 24 April 1985. During the first round of sampling, samples were collected from eight monitor wells and from two stream locations. During the second round of sampling, samples were collected from 11 monitor wells including MW-12 and MW-13 which were not sampled during the first round. No stream samples were collected during the second round of sampling.

Upon completion of these analyses, the data were inspected for those wells and soil borings exhibiting the most degraded soil and water quality. Figure ES-1 delineates areas in which fuel products had reached the groundwater and are floating on top of the water table. Depths to water and product thicknesses are summarized in Table ES-1. Two areas each with significant thicknesses of floating product were found; one in the vicinity of MW-19 and one in the vicinity of MW-18. Product thickness in the wells ranged from not detected to 5.67 feet; when thickness is corrected for well effects, the product thickness in the aquifer is found to range from not detected to 1.42 feet.

The general distribution of O&G and BTX occurrence (see Table ES-2) was consistent between sampling rounds, although concentrations were generally orders-of-magnitude lower for the second sampling round when compared to the results of the first sampling round. MW-12 had high O&G and BTX concentrations while MW-13 did not.

The probable explanation for the difference between first round and second round analytical results for MW-18, MW-19, and MW-21 is related to the purging and consequent mixing of the fluid in those wells containing several feet of floating fuel product. The amount of fuel product that was purged from the wells and the amount that was mixed with the groundwater is probably not reproducible and varied, therefore, between the two sampling rounds. This resulted in one set of samples (the first sampling round) with a much greater amount of emulsified fuel product in the samples. Results did not vary so significantly at MW-24 where only traces of free fuel were observed on the water surface prior to purging. These results indicate that representative samples of wells where two phases are present may be better accomplished by selective sampling of discrete points in the column prior to purging.

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Table ES-1

Summary of Monitor Well and Surface Elevation Survey in the Bulk Fuel Storage Area

	Depths to Water (feet)		Elevation to Top of Casing	Groundwater Elevation (feet)		Fuel Product Thickness in Well (feet)		Corrected[2] Fuel Product Thickness (feet)
Well	4/2/85	4/22/85	(feet)	4/2/85	4/22/85	4/2/85	4/22/85	4/22/85
MW-12	16.95	17.25	111.30	---	97.4[1]	---	4.77	1.19
MW-13	---	11.38	109.73	---	98.4	---	ND	ND
MW-18	17.05	16.80	108.67	94.4[1]	99.3[1]	2.66	5.00	1.25
MW-19	17.75	17.80	110.24	95.4[1]	96.3[1]	4.33	5.67	1.42
MW-20	11.94	12.04	111.13	99.2	99.1	ND	ND	ND
MW-21	15.29	15.90	108.86	95.4[1]	96.5[1]	2.58	5.00	1.25
MW-22	12.53	12.52	105.04	92.5	92.5	ND	ND	ND
MW-23	13.44	13.40	108.62	95.2	95.2	ND	ND	ND
MW-24	14.74	14.78	108.00	93.3	93.2	Surface Fraction	Surface Fraction	Surface Fraction
MW-25	13.28	13.34	109.48	96.2	96.1	ND	ND	ND

[1]Water level corrected for depression due to floating product.
[2]The height of the product in the borehole will be approximately four times the true thickness of the product layer in the aquifer (dePastrovich, et al., 1979). See Appendix F for further discussion.

ND - Not detected

--- No measurement taken

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Tabl ES-2

Summary of Water Analytical Results for the Bulk Fuel Storage Area

Location	Oil and Grease (mg/L) 4/2/85	Oil and Grease (mg/L) 4/24/85	Benzene (ug/L) 4/2/85	Benzene (ug/L) 4/24/85	Toluene (ug/L) 4/2/85	Toluene (ug/L) 4/24/85	Xylenes (ug/L) 4/2/85	Xylenes (ug/L) 4/24/85
MW-12	NS	105	NS	4,900	NS	6,000	NS	8,500
MW-13	NS	0.28	NS	ND	NS	3.0	NS	3.8
MW-18	9,300	793	320,000	6,000	310,000	14,000	1,100,000	24,000
MW-19	538	34.3	<50,000*	14,000	70,000	18,000	200,000	24,000
MW-20	0.26	0.30	ND	ND	ND	ND	ND	ND
MW-21	667	22.4	<50,000*	6,000	74,000	5,900	510,000	17,000
MW-22	0.26	0.10	ND	ND	ND	ND	11	ND
MW-23	0.24	0.15	ND	ND	ND	ND	ND	5.7
MW-24	6.77	4.44	2,200	3,500	2,100	130	19,000	6,000
MW-25	0.56	0.40	ND	ND	ND	ND	ND	ND
Field blank	0.10	0.10	ND	ND	ND	ND	ND	ND
Trip blank	0.12	---	ND	ND	ND	ND	ND	ND
Duplicate	---	0.27 (MW-20)	ND (MW-25)	ND (MW-20)	ND (MW-25)	ND (MW-20)	ND (MW-25)	ND (MW-20)
Station 1 (upgradient)	0.30	NS	ND	NS	ND	NS	ND	NS
Station 2 (downgradient)	0.37	NS	ND	NS	ND	NS	ND	NS
Detection Limit	0.1	0.1	2.0	2.0	2.0	2.0	4.0	4.0

NS - Not sampled
ND - Not detected
--- No Measurement taken

*Large interference eluting near benzene making detection and quantification of benzene impossible.

Fuel-related BTX compounds were present in association with those wells exhibiting high concentrations of O&G. High levels of O&G and BTX were detected in samples from wells MW-12, MW-18, MW-19, MW-21, and MW-24 (see Figure ES-1).

Relatively low levels of xylenes and/or toluene were found in wells MW-13, MW-22, and MW-23. BTX concentrations in samples from MW-20, MW-25, and surface water were below detection limits (see Figure ES-1).

The direction of groundwater movement in the site area has been determined to be northeast to due east. The seepage velocity for groundwater in this area is 77 ft/yr.

ES.2 SIGNIFICANCE OF FINDINGS

ES.2.1 Groundwater

As a result of the field investigation, four principal areas of groundwater contamination were identified:

- Along the northern boundary of the area in the vicinity of wells MW-12, MW-19, and MW-21 where the overland flow of fuel collected and subsequently percolated into the water table.
- Along the northern boundary of the area in the vicinity of well MW-18 where leaks occurred in the standpipes.
- Along the eastern boundary of the area in the vicinity of well MW-24 where high levels of dissolved constituents were detected.
- Outside the northwestern corner of the area fence boundary in the vicinity of soil boring 29 (see Figure ES-1).

Although the impact of free floating fuels on groundwater is limited, the fuels provide a constant supply of dissolved constituents to the groundwater system.

In the eastern portion of the site there exists a potential for off-site migration of dissolved groundwater contaminants encountered in well MW-24. There is no evidence that the migration of these constituents is limited to or contained to the eastern portion of the site. The extent of contaminant migration cannot be quantified since no downgradient groundwater sampling points are presently in-place. In order to conclusively determine the extent and the source of the contaminants in MW-24, additional field investigations would be necessary.

ES.2.2 Soils

Elevated levels of O&G in unsaturated soils occur in the same areas as fuel occurrence in the groundwater with some exceptions such as boring 29 area. Fuel in these soils is flushed to the groundwater by precipitation percolating through the soils and provides some recharge to the plume.

ES.3 RECOMMENDATIONS

Based on the findings of the field investigation and the identification of and preliminary evaluation of remedial alternatives, WESTON recommends a three-step approach for a site restoration program.

- Implementation of an immediate response alternative to recover the floating hydrocarbons.
- Identify additional data needs involving further investigation of and definition of the plume of dissolved constituents at the eastern and southeastern portions of the Bulk Fuel Storage Area (MW-24).
- Analysis of the long-term alternatives after immediate response measures have been completed.

ES.3.1 Implementation of Immediate Response Alternative

WESTON recommends the alternative that involves recovery of floating hydrocarbons from the groundwater using low-production pumping systems installed in the existing monitor wells or additionally constructed recovery wells. In addition, the recovery operations should be supplemented by a periodic monitoring and sampling program in monitor wells MW-12, MW-13, MW-18, MW-19, MW-21, and MW-22 to monitor the efficiency of the recovery operation and the potential migration of hydrocarbons to South Run.

ES.3.2 Additional Data Needs

The additional data needs identified include:

- Definition of the plume of hydrocarbon constituents dissolved in groundwater toward the eastern and south-eastern areas of the Bulk Fuel Storage Area (MW-24).
- Definition of hydrocarbon constituents in soils east and southeast of the Bulk Fuel Storage Area (MW-24).
- Development of cleanup standards and criteria for long-term remediation actions.

ES.3.3 Analysis of Long-Term Alternatives

Upon completion of the immediate response activities involving recovery of floating hydrocarbons, the monitor wells should be sampled and analyzed to determine the concentrations of and the extent of dissolved hydrocarbons in groundwater and the presence of any residual floating hydrocarbons. In view of these analytical data and the cleanup criteria and standards for long-term remediation, the long-term alternatives should be re-evaluated for technical feasibility, cost-effectiveness, implementation time frame, environmental effectiveness, and capability for implementation and operation using base manpower resources.

SECTION 1

INTRODUCTION

1.1 PURPOSE OF STUDY - INSTALLATION RESTORATION PROGRAM

In 1976, the Department of Defense (DOD) devised a comprehensive Installation Restoration Program (IRP). The purpose of the IRP is to assess and to control migration of environmental contamination that may have resulted from past operations and disposal practices and probable migration of hazardous contaminants on DOD facilities. In response to the Resource Conservation and Recovery Act of 1976 (RCRA) and in anticipation of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or Superfund), DOD issued a Defense Environmental Quality Program Policy Memorandum (DEQPPM) dated June 1980 (DEQPPM 80-6) requiring identification of past hazardous waste disposal sites on DOD agency installations. The U.S. Air Force implemented DEQPPM 80-6 by message in December 1980. The program was revised by DEQPPM 81-5 (11 December 1981) that reissued and amplified all previous directives and memoranda on the IRP. The Air Force implemented DEQPPM 81-5 by message on 21 January 1982. The Installation Restoration Program has been developed as a four-phase program as follows:

- Phase I - Problem Identification/Records Search.
- Phase II - Problem Confirmation and Quantification.
- Phase III - Technology Base Development.
- Phase IV - Corrective Action.

1.2 BASE PROFILE

McGuire Air Force Base (McGAFB) occupies 3,536 acres in south central New Jersey approximately 18 miles southwest of the City of Trenton. Figure 1-1 presents an index map showing the location of McGuire Air Force Base. The northwestern border of McGAFB is the community of Wrightstown, Burlington County, while the eastern, southern, and western borders are occupied by the U.S. Army Fort Dix installation. The base is in a rural area of the New Jersey Pine Barrens with most adjacent lands being vacant, wooded, or being used for agricultural or military purposes. The area of McGAFB is under the management of the New Jersey Pinelands Commission.

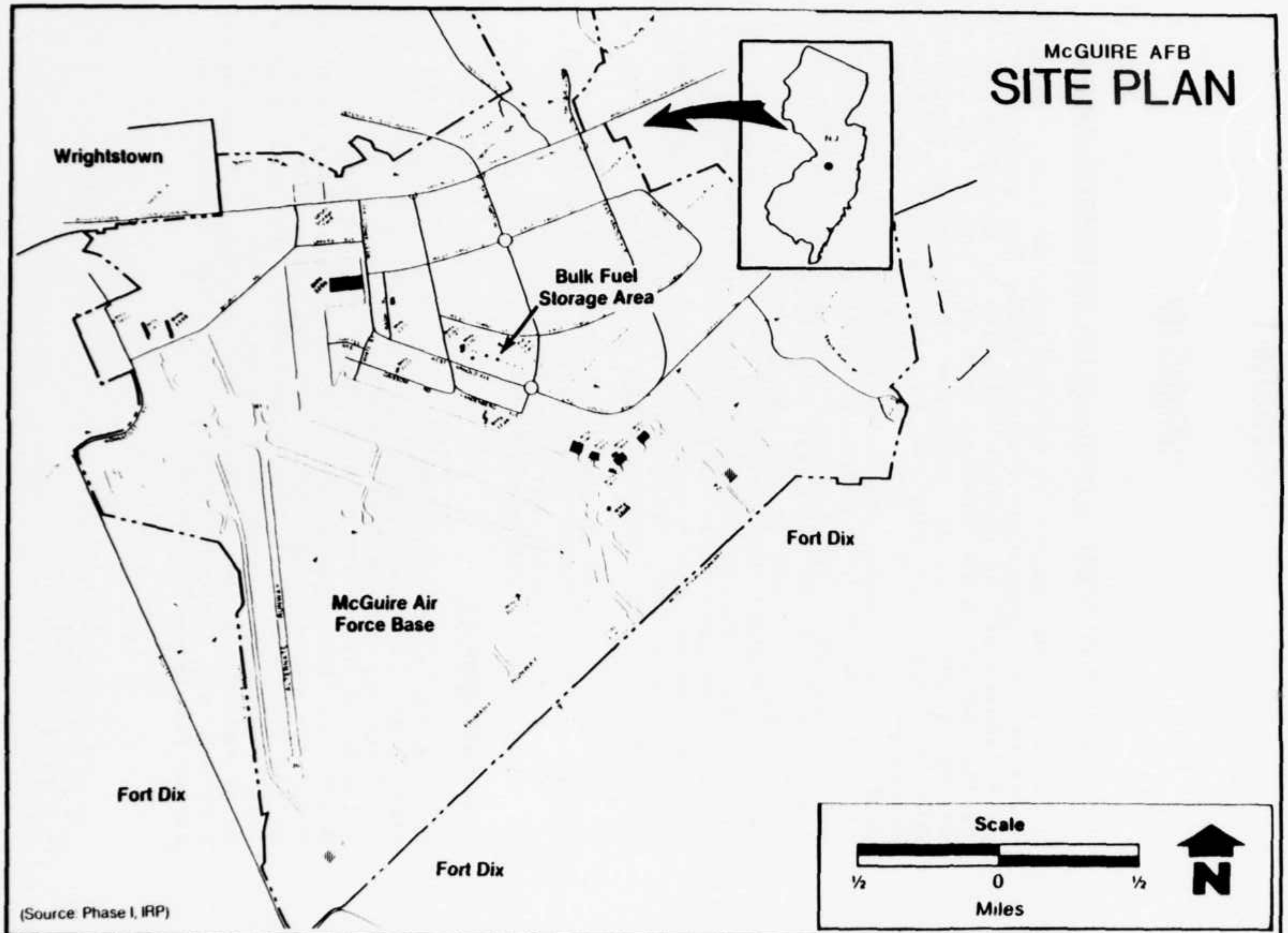

FIGURE 1-1 INDEX MAP OF MCGUIRE AFB, NEW JERSEY

In 1937, McGAFB began as a single dirt-strip runway with a few maintenance and administrative buildings. The airfield, called Rudd Field at the time, was developed as an adjunct to the U.S. Army Training Center, Fort Dix, and was operated by the U.S. Army Air Corps. From 1940 through 1942, the U.S. Army Air Corps, under Command Headquarters located at New Castle Air Base, Delaware, made extensive improvements to the Fort Dix Airfield including expanded aircraft pavements and landing strips to meet World War II transitional training requirements. The airfield remained under Army control until 1948.

In 1948, the Fort Dix Airfield and all existing facilities were transferred to the U.S. Air Force, and the installation was officially designated McGuire Air Force Base. The installation was assigned to the Strategic Air Command (SAC) until September 1949 when it was transferred to the Continental Air Command (CAC). In 1952, a major program of development was initiated to provide a port of aerial embarkation for Atlantic Division Military Air Transport Services (MATS).

In July 1954, the base was officially assigned to the Military Air Transport Service with Air Defense Command (ADC) and the New Jersey Air National Guard (NJ ANG) as major tenant organizations. NJ ANG consolidated its activities on the west side of the base supported by a Major Construction Program (MCP). Subsequently, SAC and CAC tenant units were assigned to McGAFB. In January 1966, the Military Air Transport Service became the Military Airlift Command (MAC) with headquarters at Scott Air Force Base, Illinois. Eastern Transport Air Force became the 21st Air Force with headquarters at McGAFB, and the 1611th Air Transport Wing became the 438th Military Airlift Wing (MAW). The SAC Tanker Squadron left McGAFB in 1965, and its facilities were occupied by the 170th Air Transport Group NJ ANG.

The present host organization at McGAFB is the 438th MAW whose primary mission is to provide quick-reacting, concentrated, massive airlift capabilities for emplacement of DOD forces into combat situations in a fighting posture and then to furnish material support to those forces. The Wing is also responsible for operating McGAFB and for providing adequate support to a large number of tenant units.

1.3 PURPOSE AND SCOPE

Roy F. Weston, Inc. (WESTON) has been retained by the United States Air Force Occupational and Environmental Health Laboratory (USAFOEHL) under Basic Ordering Agreement (BOA) Contract No. F33615-84-D-4400 to provide general engineering, hydrogeological, and analytical services. By message dated 4 May 1984, McGAFB requested USAFOEHL assistance in analysis and remediation of a JP-4 spill that had occurred at the base Bulk Fuel Storage Area (see Figure 1-2). In response to this request, by message dated 11 May 1984, USAFOEHL committed to provide assistance. WESTON was directed to proceed to McGAFB, to inspect the spill site, and to prepare a presurvey report for Air Force review and implementation.

The three major aspects of the fuel spill evaluation included the following:

- Identify the source, and stop the leak.
- Evaluate the distribution of fuel in soils and groundwater in the impacted area, and determine quantities, directions, and rates of migration.
- Evaluate cost-effective remedial alternatives that would establish control over further migration of contaminants and that would lead to cleanup.

McGAFB has identified the source of the spilled fuel as the lines associated with the now inactive railroad off-loading facility. The leak was effectively stopped by permanently disconnecting these lines from the fuel system. Therefore, the following Technical Scope of Work deals only with the second and third aspects of a fuel spill evaluation.

USAFOEHL issued Task Order 3 of this contract dated 20 July 1984 authorizing WESTON to perform an investigation at the base Bulk Fuel Storage Area to accomplish the above objectives. The task order (presented in Appendix B) outlined the following work:

- Completion of 30 soil borings at the site.
- Installation of eight permanent groundwater monitor wells at the site.
- Elevation survey of monitor wells.

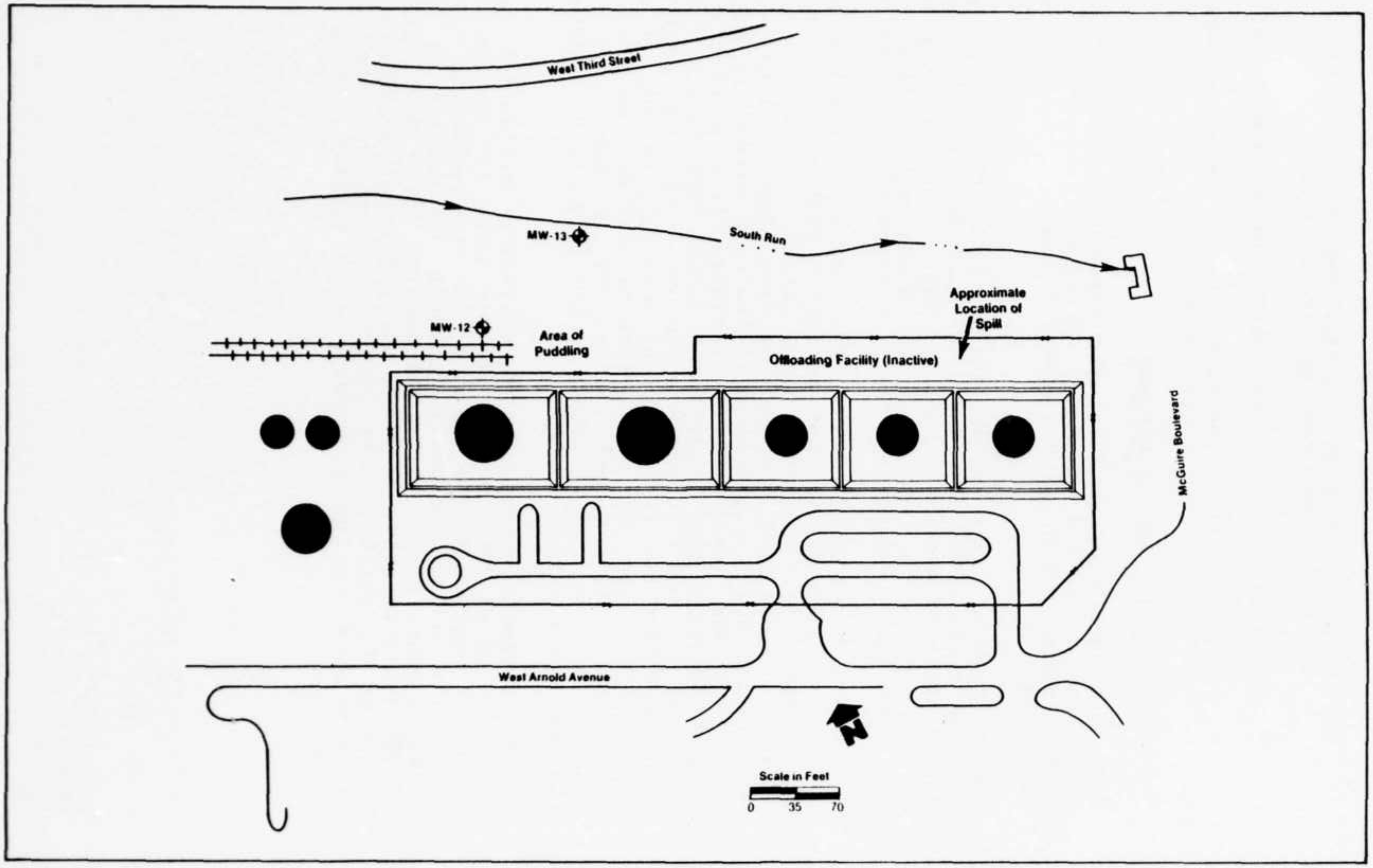

FIGURE 1-2 GENERAL SITE MAP OF THE BULK FUEL STORAGE AREA SHOWING BERM BOXES MCGUIRE AFB, NEW JERSEY

- Soil sampling at specific depths in all soil borings and in selected near-surface locations.
- Fuel product thickness measurements in each well.
- Water quality sampling of all monitor wells and seepages to South Run Creek.

1.4 SITE PROFILE AND BACKGROUND

The Bulk Fuel Storage Area, the general location of which is shown in Figure 1-2, consists of eight above-ground storage tanks located north of the runway triangle and south of South Run Creek.

The petroleum, oil, and lubricants (POL) tanks have been in service since 1963. The tanks in this area are surrounded by asphalt-covered earthen dikes. The tanks were initially used to store AVGAS, JP-4, and fuel oil. Subsequently, AVGAS storage was phased out, and the additional storage allocated to JP-4.

During the night of 26 April 1984, while on routine security patrols, McGAFB Air Police personnel detected JP-4 odors in South Run. The fuel odors were traced upstream to a point adjacent to the Bulk Fuel Storage Area where JP-4 was found to be entering South Run through a drainage ditch. It was found that fuel was leaking under pressure from a railroad off-loading facility (see Figure 1-2). Since this facility was not in active service (it is currently used to fill a standby emergency requirement), base personnel were able to cut off flow to this system from the main fueling system. Base personnel subsequently disconnected the piping at the railroad off-loading facility; this system is now physically isolated from the fuel distribution system.

The New Jersey Department of Environmental Protection (NJ DEP) was notified of the incident shortly after its occurrence, and a NJ DEP representative provided on-site guidance to McGAFB during the initial stages of cleanup and control of overland flows to South Run Creek. While on-site on 27 April 1984, the NJ DEP representative prepared and delivered to McGAFB NJ DEP Notice of Violation No. 84-4-27-03S citing the base for discharging JP-4 to the groundwater and surface waters of the State.

1.5 CONTAMINATION PROFILE

During an inspection of the site on 14 May 1984, WESTON either observed or was advised of the following conditions:

- The fuel spill occurred in a former railroad off-loading facility; the tracks and ties have been removed by the base since the spill. Fuel-contaminated ballast was also removed and stockpiled on-site.

- After the leakage was confirmed, the hydrants and connecting pipes were disconnected from the system. The pipes were backflushed with water to clear out fuel. All liquid was recovered and treated off-site.

- The leaking facility parallels South Run which is at a distance of 150 feet or less. Patches of oil-contaminated surface soils were observed between the leak area and South Run. An overland flow of fuel occurred along the railroad line, and fuel puddled near existing monitor well MW-12 (see Figure 1-2).

- McGAFB reported observing up to 36 inches of fuel in IRP monitor well MW-12 with no oil appearing in IRP monitor well MW-13. MW-12 is located near where the overland flow of fuel ponded. No fuels were found in either well during the IRP sampling in early December 1983, although MW-12 did contain slightly elevated O&G levels.

- Oil booms were placed across South Run, but no oil was seen on the water surface. No bank seepage of fuel was observed during this investigation.

As the primary parameters for evaluation of fuel migration and subsequent groundwater contamination, WESTON used the following analytes:

- U.S. EPA volatile organic and aromatic hydrocarbons that are components of JP-4:

  - Benzene,
  - Toluene, and
  - Xylenes (BTX).

- Oil and grease (O&G).

WESTON used these analytes as the primary parameters for evaluation of groundwater contamination. All soils (16 surface soil samples and 44 soil boring samples) were analyzed for O&G. All water samples were analyzed for O&G and BTX. Sampling was accomplished in accordance with U.S. EPA standard protocols, and the analyses were performed using U.S. EPA Standard Methods 413.2 for O&G and 602 for BTX. Upon completion of these analyses, the data were inspected for those wells and soil borings exhibiting the most degraded soil and water quality. Isoconcentration maps of detected contaminants were prepared to provide an indication of the probable magnitude and extent of fuel migration.

1.6 PROJECT TEAM

The Phase II Stage 2 Study at McGAFB was conducted by staff personnel of Roy F. Weston, Inc. and was managed through WESTON's home office in West Chester, Pennsylvania. The following personnel served lead functions for this project:

Mr. Peter J. Marks, Program Manager: Corporate Vice President and Air Force OEHL Program Manager, Master of Science in Environmental Science, 20 years experience in laboratory analysis and applied environmental sciences.

Mr. Frederick Bopp, III, Ph.D., P.G., Project Manager: Doctor of Philosophy in Geology and Geochemistry, Registered Professional Geologist, over 8 years experience in hydrogeology and applied geological sciences.

Ms. Katherine Sheedy, P.G., Project Manager: Master of Science in Geological Sciences, Registered Professional Geologist, over 11 years experience in hydrogeology and environmental geology. Ms. Sheedy has been Project Manager since April 1985.

Mr. Richard C. Johnson, Project Geologist: Master of Arts in Geological Sciences, 7 years experience in geotechnical engineering and hydrogeology.

Mr. Walter M. Leis, P.G., Geotechnical Quality Assurance Officer: Corporate Vice President, Master of Science in Geological Sciences, Registered Professional Geologist, over 10 years experience in hydrogeology and applied geological services.

<u>Mr. Earl Hansen, Ph.D., Analytical Laboratory Manager</u>: Doctor of Philosophy in Chemistry, over 15 years experience in laboratory analysis.

<u>Mr. John Williams, Associate Project Geologist</u>: Bachelor of Science in Earth Sciences, over 5 years experience in geological and geophysical sciences.

Professional profiles of these key personnel as well as those of other project personnel are contained in Appendix C.

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SECTION 2

ENVIRONMENTAL SETTING

2.1 REGIONAL GEOLOGY

McGuire Air Force Base is located along the southern boundary of the inner coastal plain section of the Atlantic Coastal Plain Physiographic Province. This physiographic division, characterized by low dissected hills and broad sandy plains, occurs in a narrow belt 10 to 20 miles wide and extends northeasterly along the southern Delaware Valley to Raritan Bay.

Geologic units ranging in age from Cretaceous to Quaternary have been identified in the New Jersey Coastal Plain. These units are typically unconsolidated materials consisting of gravel, sand, silt, clay, glauconite, marl, and organic materials reposing on a Pre-Cambrian/Lower Paleozoic crystalline basement complex. Coastal Plain sediments form a southeasterly dipping wedge thickening to the southeast with individual geologic units tending to thicken down dip and possessing an average unit dip ranging from 10 to 45 feet per mile.

The geology of McGAFB is dominated by interbedded continental and near-shore marine sands and clays of the Cohansey (Tch), Kirkwood (Tkw), and Vincentown (Tvt) Formations. The surficial geology of McGAFB is illustrated in Figure 2-1. The Kirkwood and Vincentown stratigraphic units reach a combined maximum thickness of approximately 50 feet in the general area of McGAFB. The Cohansey forms a thin veneer over much of the base which is in hydraulic connection with the underlying Kirkwood Formation. The Cohansey, Kirkwood, and Vincentown Formations are of hydrogeologic interest because they occur at or near ground surface in the vicinity of McGAFB. These hydrogeologic units are generally permeable and relatively thin. The Cohansey Formation consists of coarse to medium sands that overlie the fine to medium sands and clay interbeds of the Kirkwood Formation.

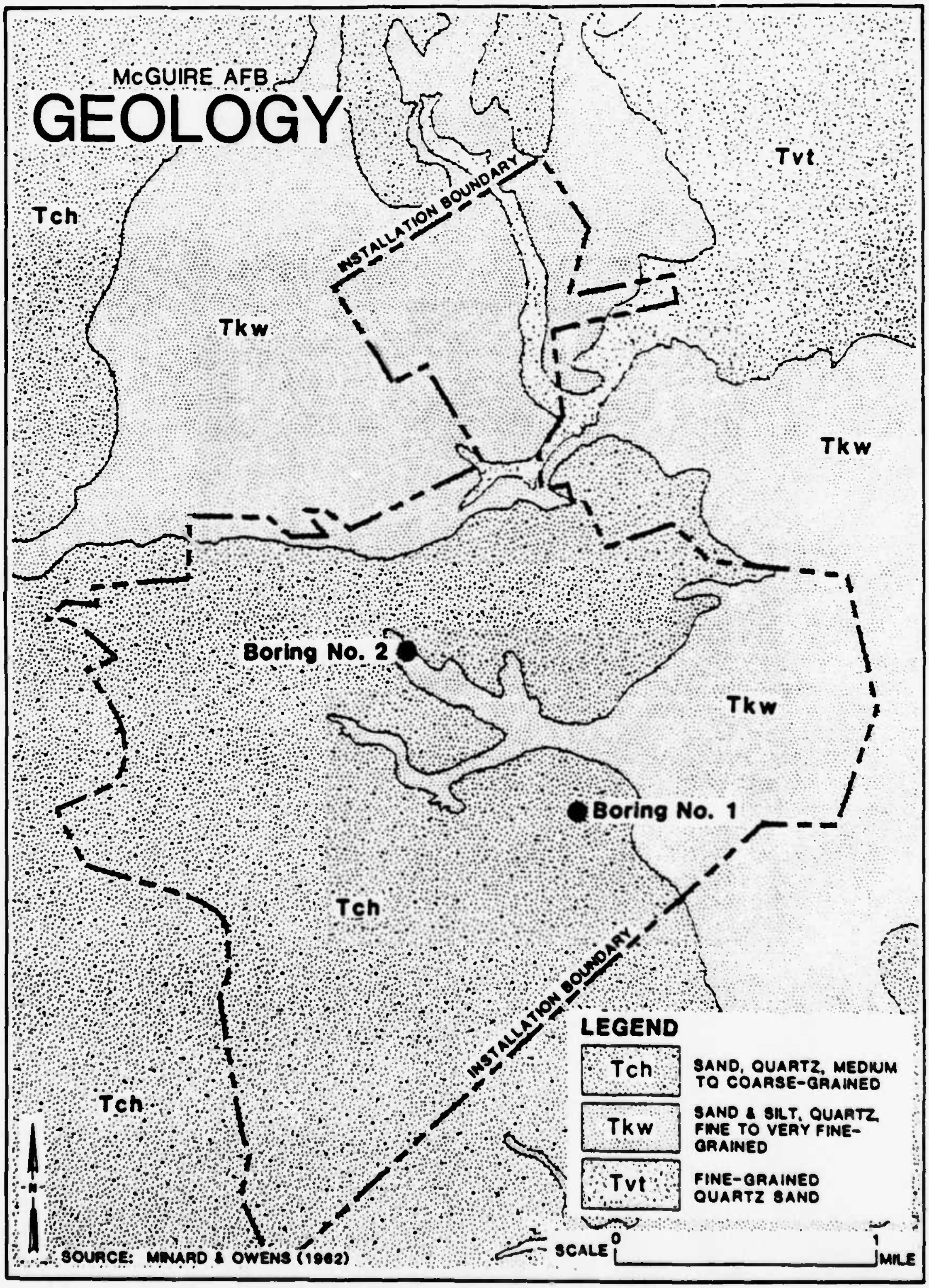

FIGURE 2-1 SURFICIAL GEOLOGY OF McGUIRE AFB, NEW JERSEY

2.2 TOPOGRAPHY AND SURFACE DRAINAGE

The topography at McGAFB ranges from generally level to gently rolling. Local relief is primarily the result of dissection by erosional activity or stream channel development. Surface elevations at the Bulk Fuel Storage Area range from a low of 80 feet above mean sea level (MSL) along the South Run Stream channel to 109 feet above MSL at the facility boundary. Mounds of construction debris are present in the vicinity of MW-13 adjacent to South Run Stream. A wide depression 1 to 2 feet deep is located between MW-18 and MW-22 apparently due to surface soil removal activities following the fuel spill.

The general drainage pattern encompassing the Bulk Fuel Storage Area is predominantly northeast toward South Run Stream and south-southwest toward storm drains along Arnold Avenue and McGuire Boulevard.

2.3 GROUNDWATER OCCURRENCE

The Cohansey and Kirkwood Formations are locally hydraulically connected. The Vincentown Formation contains water in localized water-bearing beds that may yield small to moderate quantities of water to wells screened within them.

Recharge of the Cohansey and Kirkwood Formations occurs primarily by direct precipitation in the outcrop area. Most of the land area of McGAFB is situated in the Cohansey-Kirkwood recharge zone. Once water enters the hydraulic regime, it flows under water table conditions toward zones of decreasing hydraulic head. The shallow water table system possesses fairly short flow paths. Under normal climatic conditions and typical hydraulic gradients, the flow rate in the shallow water table is estimated to be on the order of 4 feet per day. Water detention time for the Cohansey-Kirkwood is not expected to exceed 5 years. It has been estimated that 85 percent of the precipitation that infiltrates to the surficial aquifer system follows the shallow flow path and is discharged to a surface water body as base flow (New Jersey Pinelands Commission, 1980).

The Potomac-Raritan-Magothy (Kmr) aquifer system of Lower Cretaceous Age underlies the previously described tertiary deposits at depth, is regional in extent, and is the primary source for potable water supplies in the base area. This unit occurs at an approximate elevation of -450 feet MSL, and is about 550 feet thick under McGAFB. The Potomac-Raritan-Magothy rests on crystalline basement rock; its upper limit is accepted to be the Late Cretaceous Merchantville Formation and the Woodbury Clay. It thickens to over 2,000 feet in a down dip direction.

2.4 SITE HYDROGEOLOGY

The area encompassing the northern portion of the Bulk Fuel Storage Area is underlain by approximately 10 feet of sandy fill, a horizon of sandy soil and peat, and dark interbedded clayey sands of the Kirkwood Formation. The groundwater table occurs below the base of the fill at shallow depths (< 10 feet) under water table (unconfined) conditions. When compared with elevations of South Run Creek, the well water elevations depict the groundwater gradient to be in a general northeast direction toward the stream where the shallow portion of the groundwater is discharged as base flow. The stream bed itself lies on Kirkwood sediments below the elevation of the fill. Recharge to the water table is primarily through direct precipitation and percolation through the porous overlying soils. Paved portions of the facility prohibit recharge, and much of the potential recharge is directed to nearby streams by the base storm drainage system.

The southern portion of the Bulk Fuel Storage Area is directly underlain by light-colored sandy sediments probably belonging to the Cohansey Formation. These are underlain by the Kirkwood sediment at depths of 20 to 25 feet below the surface. The water table occurs in the sands at about 15 feet below ground surface. Although the water table surface is continuous across the site, there is a change in the direction of flow: the groundwater flow direction near South Run Creek is primarily to the north toward South Run Creek, while in the southern portion of the site the groundwater flow is primarily to the east, parallel to the stream and in the direction of regional groundwater flow.

SECTION 3

FIELD PROGRAM

3.1 INTRODUCTION

The field investigation conducted at McGAFB was started on 4 March 1985 and was completed on 24 April 1985. The Scope of Work under Task Order 3 is summarized in Table 3-1. The lapse of time between the original authorization to proceed (20 July 1984) and the actual start of field work represents the period of review and approval of the Scope of Work by the New Jersey Department of Environmental Protection. The complete Scope of Work is included in Appendix B. Table 3-2 is a summary calendar of WESTON's field activities for this investigation.

3.2 DRILLING PROGRAM

The field investigation at McGAFB included the completion of 30 investigative soil borings and the installation of 8 permanent monitor wells. Drilling was completed by Empire Soil Investigations, Inc., Edison, New Jersey, under the direction of WESTON geologists. The drillers are registered in the State of New Jersey. Drilling and well installation was completed with a truck-mounted auger rig. Drilling sites were cleared for buried utilities by the Base Civil Engineering Office prior to the start of drilling. Drill cuttings were temporarily stored on plastic sheets. At the completion of the drilling program, contaminated soils (based on HNu readings) were placed in drums and stored in a secure area by the Base Civil Engineering Department. The remaining cuttings were placed on an on-site soil stockpile. Between boring locations, all drilling equipment was steam cleaned to prevent cross-contamination between bore holes.

3.2.1 Exploratory Soil Borings and Temporary Well Points

A total of 30 soil borings were completed in the Bulk Fuel Storage Area area using 4-3/4-inch inner diameter hollow-stemmed augers. Boring locations are shown in Figure 3-1. The majority of borings were located along the railroad bed and between the Bulk Fuel Storage Area and South Run. Borings 13 and 30 were located along the eastern boundary of the Bulk Fuel Storage Area, downgradient of the Bulk Fuel Storage Area in relation to the regional direction of groundwater flow.

Table 3-1

Summary of Scope of Work Completed Under Task Order 3, McGuire AFB

- Completion of 30 soil borings to obtain subsurface soil samples, to identify depth to groundwater, and to confirm the presence of fuel product in soils and groundwater.
- Location of 50 surface sampling points, and recovery of 0- to 2-foot depth samples with split-spoon or hand-auger.
- Screening of surface and subsurface soils samples for the presence of organic vapors using a HNu photoionization meter.
- Selection of surface and subsurface soil samples for analysis of O&G.
- Sampling of new and existing wells (2 rounds) for analysis of O&G and BTX.
- Sampling of surface water for analysis of O&G and BTX.

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Table 3-2

Summary of Field Activities for Task Order 3, Bulk Fuel Storage Area Subsurface Investigation - McGuire Air Force Base, New Jersey

Activity	Date
Job-opening meeting at McGAFB; included base personnel and NJ DEP representative.	8 February 1985
Clear drilling locations.	4-5 March 1985
Install 30 temporary soil borings. Sample soil for O&G.	5-12 March 1985
Perform soil boring elevation survey.	9 March 1985
Install eight groundwater monitor wells.	11-14 March 1985
Develop monitor wells.	14-18 March 1985
Perform monitor well elevation survey.	28 March 1985
Collect samples of shallow surface soils.	29 March 1985
Remove PVC from and grout temporary soil borings.	2 April 1985
Collect first set of groundwater and surface water samples. Measure petroleum product thicknesses.	3 April 1985
Collect second set of groundwater and surface water samples. Measure petroleum product thicknesses.	22-24 April 1985

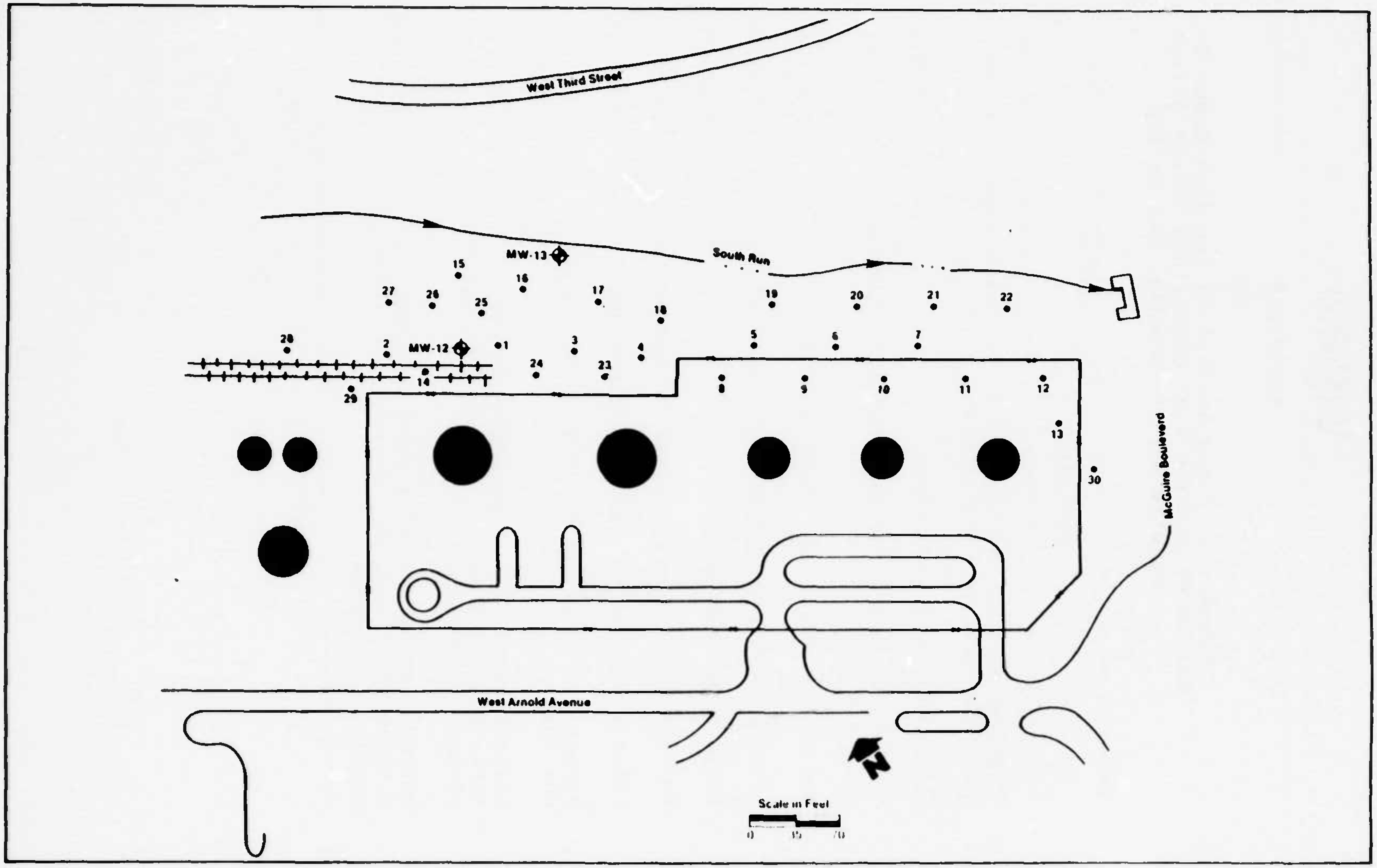

FIGURE 3-1 GENERAL SITE MAP OF THE BULK FUEL STORAGE AREA SHOWING SOIL BORING LOCATIONS McGUIRE AFB, NEW JERSEY

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Soil samples were taken in advance of the hollow-stemmed augers with a 2-inch diameter split-spoon sampler in accordance with the ASTM Standard Penetration Test Method D-1586. Borings were terminated approximately 2 feet into the saturated zone (around 10 to 13 feet). Prior to withdrawing the augers, a length of 1-1/2-inch diameter hand-slotted PVC pipe was installed in each boring to allow monitoring of water levels and any free-floating fuel product. All split-spoon samples were logged by a WESTON geologist who recorded relevant information such as sample description, sampler driving blow counts, degree of saturation, and the presence of soil-gas measured with an HNu meter. These logs are included in Appendix D. Select soil samples were packed and logged for chemical analysis as discussed in more detail in Subsection 3.4.2.

On 2 April 1985, all temporary well points were removed, and the borings were either backfilled with cement grout or redrilled, and a permanent 4-inch monitor well was installed.

The well points were allowed to stabilize for at least 24 hours before water level measurements were made. In addition, any visible presence or measurable thickness of fuel product in the water column was noted, and an explosimeter reading was taken at the top of the PVC pipe. The results of three rounds of water level measurements are summarized in Table 3-3. A bottom-entry glass bailer was used to measure floating fuel product thickness on the water surface. These results also are presented in Table 3-3. Since the well points were not developed, these measurements are only a rough indication of fuel product present in the groundwater.

Based on the information obtained by the temporary well points, permanent groundwater monitor wells were installed around the site.

3.3 ELEVATION SURVEY

WESTON surveyed the tops of the PVC casings of all 30 temporary well points, and eight permanent monitor wells were surveyed for elevation to the nearest 0.01 foot. Surface water elevation references also were established at locations along the South Run adjacent to nearby monitor wells.

The purpose of the survey was to establish references from which to measure groundwater and surface water elevations so that the gradient and direction of flow of groundwater to South Run discharge points could be established. All elevations were referenced to MW-12 which is in turn referenced to permanent benchmarks located on the base.

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Table 3-3

Water Table and Fuel Product Thicknesses for Temporary Well Points (9 March 1985)

Boring No.	Depth to Water (feet below top) of casing)	Fuel Product Thickness (feet)
SB-1	15.25	>0.7
SB-2	10.94	0.0
SB-3	12.68	---
SB-4	13.50	0.0
SB-5	13.55	0.0
SB-6	15.94	>0.7
SB-7	9.98	0.0
SB-8	12.86	0.0
SB-9	13.71	0.0
SB-10	12.35	0.0
SB-11	12.55	0.0
SB-12	12.46	0.0
SB-13	14.48	0.0
SB-14	11.75	Surface film
SB-15	12.37	>0.7
SB-16	12.22	0.1
SB-17	13.10	0.0
SB-18	12.54	0.0
SB-19	9.76	0.0
SB-20	9.08	0.0
SB-21	12.55	0.0
SB-22	8.05	0.0
SB-23	12.67	0.0
SB-24	15.20	>0.7
SB-25	12.82	>0.7
SB-26	12.22	>0.7
SB-27	11.32	0.0
SB-28	11.25	0.0
SB-29	11.38	0.0
SB-30	16.18	0.0

--- No measurement taken

3.4 SOIL SAMPLING

A total of 71 soil boring samples and 50 shallow soil samples distributed along the pathway of the spill were collected in and around the Bulk Fuel Storage Area. Soil boring and surface sampling locations are shown in Figures 3-1 and 3-2, respectively. Based on the readings from the HNu vapor detector and from visual inspections, discrete or composite soils samples were taken from intervals determined to be contaminated. A total of 44 soil boring samples and 16 shallow soil samples were submitted to the WESTON laboratory for analysis. Duplicate samples were forwarded to USAFOEHL for identical analysis. A discussion of field sampling QA/QC procedures and safety protocols is presented in Appendix E.

3.4.1 Soil-Gas Monitoring

Through the sampling program, each bore hole and sample was monitored for soil-gas using an HNu Model PI101 photoionization detector. A qualitative HNu scan was performed to sense volatile organic compounds and select inorganic compounds of contrasting ionization potentials.[1] The values obtained in the field from the HNu scans were incorporated into the boring logs.

3.4.2 Soil Borings

Subsoils within the Bulk Fuel Storage Area were sampled by the boring methods summarized in Subsection 3.2.1. Upon retrieval of the split-spoon sampler, each soil sample was extracted and physically characterized. Samples also were scanned for organic vapors using the protocol summarized in the preceding subsection. Physical characteristics noted in the descriptions of the samples included discoloration, textural properties, water content, and composition.

Samples exhibiting anomolous characteristics (e.g., positive HNu values, discoloration) were stored as discrete samples for specific depths and borings. Soil samples for those borings showing no anomolous characteristics were composited from ground surface to the depth of termination. This procedure was part of the criteria used in selecting samples to be submitted for laboratory analysis. The locations of the 30 soil borings and existing wells MW-12 and MW-13 are shown in Figure 3-1. A total of 71 soil boring samples were taken out of which 44 were submitted for laboratory analysis for O&G. Table 3-4 is a summary of subsurface soil samples and the results of HNu screening.

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[1]The HNu is not sensitive to methane. Methane would be expected to occur naturally in the organic soils encountered in some of the borings.

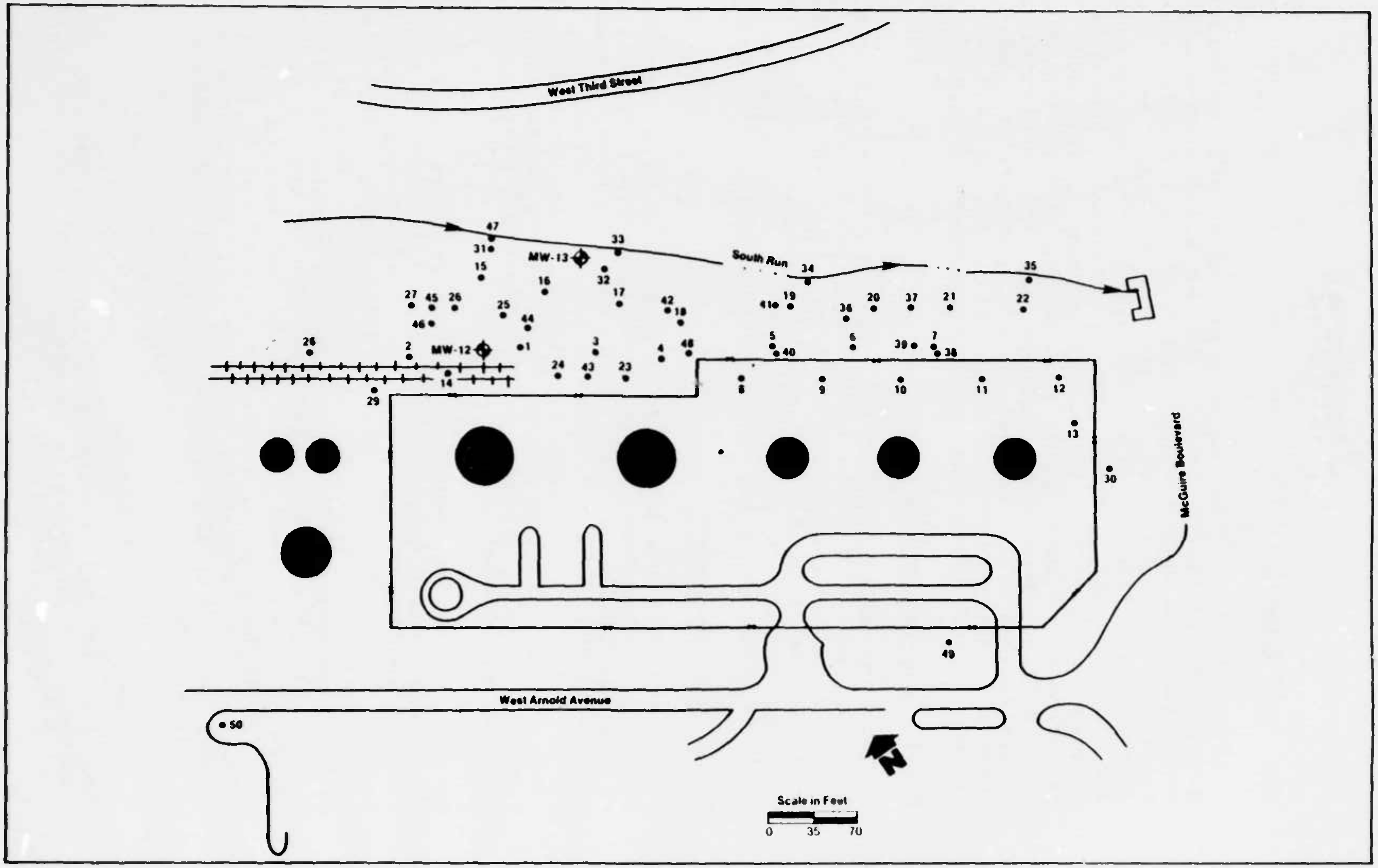

FIGURE 3-2 GENERAL SITE MAP OF THE BULK FUEL STORAGE AREA SHOWING SHALLOW SURFACE SOILS SAMPLES McGUIRE AFB, NEW JERSEY

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Table 3-4

Summary of Subsurface Soil Samples with Field HNu Readings

Boring No.	Depth Interval (feet)	Field HNu Reading (ppm)	Submitted for Analysis
SB-1	0-2	0.3	
	5-7	60	X
	10-12	75	X
	15-17	25	
SB-2	0-2	0.3	
	5-7	70	X
	10-12	100	X
	15-17	50	
SB-3	5-7	8.0	X
	10-12	100	X
	15-17	6.0	
SB-4	5-7	7.0	X
	10-12	6.0	X
	15-17	8.0	
SB-5	0-2	105	X
	5-7	20	X
	10-12	4.5	
	15-17	5.0	
SB-6	5-7	60	X
	10-12	85	X
	15-17	25	
SB-7	5-7	2.3	X
	10-12	2.5	
	12-14	3.5	

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Table 3-4
(continued)

Boring No.	Depth Interval (feet)	Field HNu Reading (ppm)	Submitted for Analysis
SB-8	0-2	1.0	
	5-7	4.5	
	7-9	3.0	X
	9-11	0.3	
	11-13	0.3	
SB-9	0-2	0.3	
	5-7	0.3	
	7-9	0.3	
	9-11	0.3	
	11-13	0.3	
SB-10	0-2	0	
	5-7	0	X
	7-9	0	
	11-13	0	
SB-11	0-2	0	Composite
	5-7	0	
	7-9	0	
SB-12	0-2	0	Composite
	5-7	0	
	7-9	0	
	9-11	0	
	11-13	0	
SB-13	0-2	0	
	5-7	0	
	7-9	0	Composite
	9-11	0	
	11-13	5	

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Table 3-4
(continued)

Boring No.	Depth Interval (feet)	Field HNu Reading (ppm)	Submitted for Analysis
SB-14	0-2	0	Composite
	5-7	0	
	7-9	0.2	
	9-11	60	
	11-13	---	X
SB-15	0-2	0	
	5-7	0	
	9-11	50	
	11-13	80	X
SB-16	0-2	0	
	5-7	0	
	7-9	0	Composite
	9-11	0	
	11-13	0	
SB-17	0-2	0	
	5-7	0	
	7-9	0	Composite
	9-11	0	
	11-13	0	
SB-18	0-2	5	X
	5-7	0	
	7-9	0	Composite
	9-11	0	
	11-13	0	

--- No measurement taken.

Table 3-4
(continued)

Boring No.	Depth Interval (feet)	Field HNu Reading (ppm)	Submitted for Analysis
SB-19	0-3	0	
	5-7	0	
	7-9	0	Composite
	9-11	0	
	11-13	0	
SB-20	0-2	0	
	5-7	0	
	7-9	0	Composite
	9-11	0	
SB-21	0-2	0	
	5-7	0	
	7-9	0	Composite
	9-11	0	
SB-22	0-2	0	
	5-7	0	
	7-9	0	Composite
	9-11	0	
SB-23	0-2	0	
	5-7	0	
	7-9	0	Composite
	9-11	0	
	11-13	0	

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Table 3-4
(continued)

Boring No.	Depth Interval (feet)	Field HNu Reading (ppm)	Submitted for Analysis
SB-24	0-2	5	
	5-7	50	
	7-9	100	X
	9-11	45	
	11-13	150	X
SB-25	0-2	2.2	
	5-7	---	X
	7-9	50	
	9-11	75	X
	11-13	35	
	15-16	20	
SB-26	0-2	3.0	
	5-7	---	X
	7-9	0.6	
	9-11	50	X
	11-13	50	
	15-16	40	
SB-27	0-2	0	Composite
	5-7	1.2	Composite
	7-9	1.0	Composite
	9-11	15	Composite
	11-13	0	X
SB-28	0-2	0.2	Composite
	5-7	0	Composite
	7-9	0	Composite
	9-11	0	Composite

--- No measurement taken.

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Table 3-4
(continued)

Boring No.	Depth Interval (feet)	Field HNu Reading (ppm)	Submitted for Analysis
SB-29	0-2	0	
	5-7	0	X
	7-9	20	X
	11-13	5	
SB-30	0-2	0.3	
	5-7	1.0	
	7-9	2.0	Composite
	9-11	2.0	
	11-13	60	X

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3.4.3 Surface Samples

A total of 50 discrete surface soil samples were collected at locations shown in Figure 3-2. Sampling was conducted with a split-spoon or hand trowel in the 0- to 2-foot soil horizon in the immediate vicinity of the fuel spill. Each sample was monitored for organic vapors and the physical properties noted. Sixteen samples were submitted to the WESTON laboratory for O&G analysis.

3.5 MONITOR WELL INSTALLATION

3.5.1 Location of Monitor Wells

Monitor well locations were determined based on the results of the information obtained from the temporary well points, and existing wells MW-12 and MW-13. These wells were installed during Phase II Stage 1 activities in 1983. The two existing and eight additional permanent wells placed in the Bulk Fuel Storage Area are shown in Figure 3-3. Wells MW-20 and MW-23 were located upgradient of the Bulk Fuel Storage Area along West Arnold Avenue to provide background sampling locations. Three downgradient wells (MW-18, MW-19, and MW-21) were located in the same boreholes as SB-6, SB-25, and SB-15, respectively, because these soil borings exhibited the highest petroleum product thicknesses. MW-22 and MW-24 were located downgradient just outside the southeast Bulk Fuel Storage Area fence boundary. Well MW-25 was located downgradient and immediately within the southeast corner of the Bulk Fuel Storage Area.

3.5.2 Monitor Well Construction

A total of eight monitor wells were installed during the field investigation. All wells were installed according to NJ DEP specifications and were permitted according to State regulations. The following installation methods and construction were utilized for all wells: 6-3/4-inch inside diameter hollow-stemmed augers were advanced to approximately 10 feet below the water table. Then, a 4-inch diameter flush-threaded PVC riser pipe and a 15-foot length of screen were inserted through the augers. The augers were then slowly withdrawn as a sand pack was poured into the annular space around the screen. Bentonite pellets were then placed on top of the sand pack to seal the screened interval from vertical infiltration through the annular space. The seal was completed by filling the annular space to the surface with a nonshrinking cement grout as the augers were withdrawn. Care was taken to prevent the collapse of the annular space above the sand pack and to ensure a continuous bentonite and grout seal. Well construction was completed by installing a 6-inch diameter steel protective casing cemented in place over the wellhead.

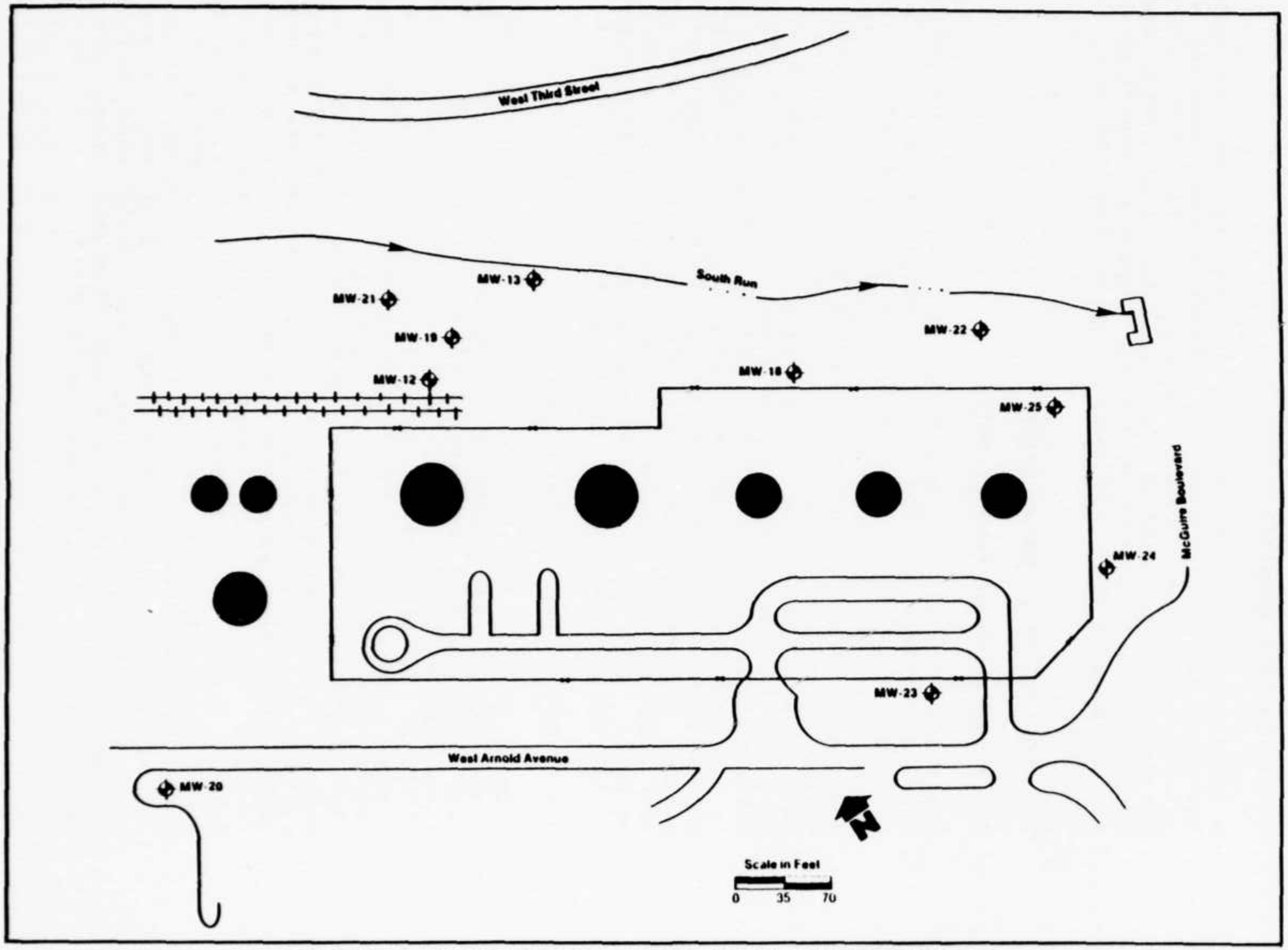

FIGURE 3-3 GENERAL SITE MAP OF THE BULK FUEL STORAGE AREA SHOWING MONITOR WELL LOCATIONS

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A typical well construction diagram is presented in Figure 3-4. Well logs and completion diagrams for each well are presented in Appendix D and and summarized in Figure 3-5 and in Table 3-5. Upon completing all the installations, each well was developed (by pumping) to stabilize the sand pack and increase the yield. Pumpage from MW-18, MW-19, and MW-21 ranged from "pure" fuel product to an emulsified mixture of fuel and water. All water discharged from these wells was containerized and transported to the base oil separator plant for treatment. It is estimated that approximately 25 percent of the 500 gallons pumped from these wells during development was concentrated fuel.

3.6 WATER QUALITY SAMPLING

The purpose of the water quality sampling program was to identify, insofar as possible at the level of a confirmation survey, the existence of fuel contamination present in the hydrogeologic environment of the Bulk Fuel Storage Area monitor wells. To achieve these goals efficiently, specific field procedures were developed for purging the wells, for collecting the samples, and for ensuring field quality control. These procedures have been used to obtain two complete rounds of representative samples for chemical analysis. The sampling and quality assurance procedures and safety protocols are contained in Appendix E.

In accordance with Task Order 3, the water quality sampling program included the collection of two rounds of samples. Each of the eight newly installed monitor wells was sampled twice. Two additional sampling locations also were identified for seeps in the bank of South Run. However, no seepage was observed at any time during the study. Therefore, during the first round of sampling, surface water samples were taken directly from South Run. As the results were negative, the stream was not sampled during the second round. Instead, samples were taken from wells MW-12 and MW-13 (installed in 1983). All samples were analyzed for O&G and BTX.

Sample containers were prepared in WESTON's laboratory in accordance with standard U.S. EPA procedures and protocols and consisted of the following:

- BTX: 40-mL glass septum vials with Teflon-lined lids.
- O&G: 1-liter amber glass containers preserved with H_2SO_4.

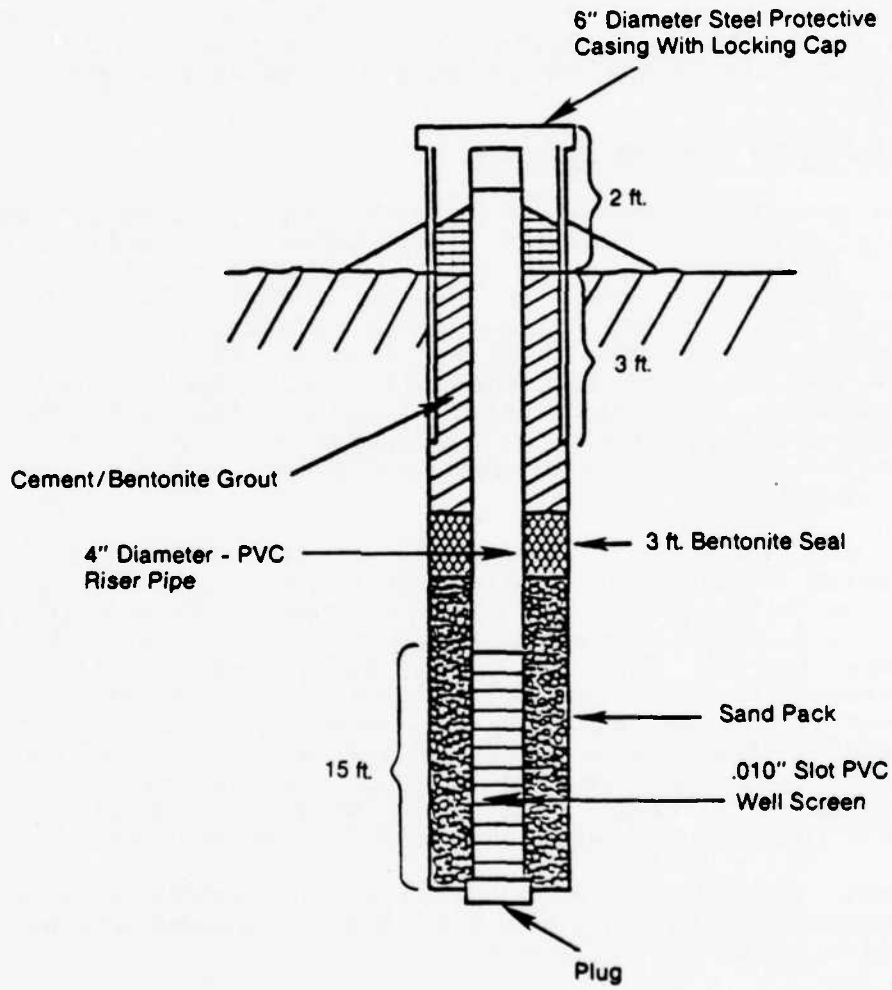

FIGURE 3-4 SCHEMATIC OF MONITOR WELL CONSTRUCTION, STAGE 2 - BULK FUEL STORAGE AREA

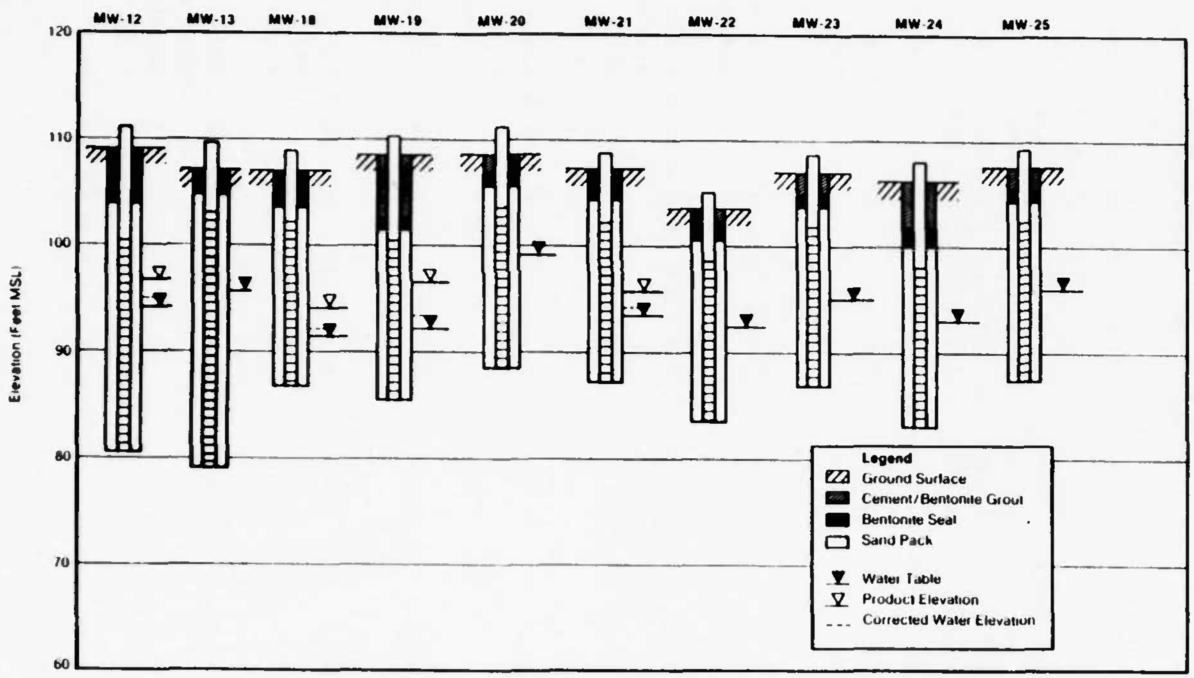

FIGURE 3-5 WELL CONSTRUCTION SUMMARY MW-12, MW-13, AND MW-18 THROUGH MW-25 - BULK FUEL STORAGE AREA McGUIRE AFB, NEW JERSEY

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Table 3-5

Summary of Well Construction Details Bulk Fuel Storage Area, McGuire Air Force Base

Monitor Well No.	Approximate Land Surface (feet)	Top of PVC Casing Elevation (feet)	Screened Interval Depth (feet BGS)	Sandpack Interval Depth (feet BGS)	Sediment Descriptions in Screened Zones
MW-12[1]	109.0	111.30	7 - 27.0	5 - 27	Olive-brown f-m silty sand interbeds of gravel and clay.
MW-13[1]	107.2	109.73	7 - 27.0	5 - 27.0	Olive-brown silty sand and silty clay.
MW-18	107.0	108.67	5 - 19.9	3.5 - 19.9	Olive-green sand, medium grading to sandy silt, with some clay and organic material.
MW-19	108.6	110.24	8 - 21.5	6 - 21.5	Green and gray silt and clay with some sand and organic material.
MW-20	108.7	111.13	5 - 19.0	3 - 19.0	Orange to brown sand with some gravel and silt.
MW-21	107.4	108.96	5 - 20.2	3 - 20.2	Fill, black to brown sand, ash, clay, and sludge.
MW-22	103.5	105.04	5 - 18.9	3 - 18.9	Brown to white sand and silt with distinct change to black and brown sandy silt.

[1]Installed in October 1983.

BGS - Below ground surface

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Table 3-5
(continued)

Monitor Well No.	Approximate Land Surface (feet)	Top of PVC Casing Elevation (feet)	Screened Interval Depth (feet BGS)	Sandpack Interval Depth (feet BGS)	Sediment Descriptions in Screened Zones
MW-23	107.0	108.62	5 - 19.3	3 - 19.3	Brown sand, coarse, grading to gray silt and then to organic clay.
MW-24	106.2	108.00	8 - 23.0	6 - 23.0	Tan and gray sand, fine to coarse.
MW-25	107.7	109.48	5 - 19.5	3 - 19.5	Green and black sand, damp, with some gravel and clay.

BGS - *Below ground s rface*

3.6.1 Well Purging and Sampling

Prior to purging, fuel product thicknesses and water levels were measured in each monitor well using tape and oil-sensitive paste. Wells that sustained pumping and were free of floating product (MW-20, MW-23, and MW-25) were pumped continuously until the equivalent of three to five volumes of the saturated casing depth were removed. These wells produced a maximum of from one to three gpm. Those wells containing product (MW-18, MW-19, MW-21, and MW-24) were bailed by hand using a 3-liter Teflon bailer until a minimum of three to five volumes of water were displaced. All water bailed from these wells was containerized in 55-gallon drums supplied by Civil Engineering. During the sampling, measurements were made at each well of pH, temperature, and specific conductance. These results are summarized in Table 3-6.

Upon completion of purging, samples for O&G and BTX were extracted using a 1-liter Teflon bailer. A strict procedure of equipment decontamination (Appendix E), including pumps and bailers, was followed throughout the sampling program.

Table 3-6

Summary of Field-Tested Water Quality Parameters in the Bulk Fuel Storage Area

	Temperature (°C)		Specific Conductance (micro-mhos/cm)		pH[2]	
Well	4/03/85	4/24/85	4/03/85	4/24/85	4/03/85	4/24/85
MW-12	12	12	570.0	652.0	7.0	7.0
MW-13	13	13	1,170.0	1,239.0	7.0	7.0
MW-18	13	12	---*	161.0	7.0	7.0
MW-19	12	13	---*	1,018.0	7.0	7.0
MW-20	22[1]	24	289.0	320.0	7.0	7.0
MW-21	12	13	---*	608.0	7.0	7.0
MW-22	13	12	401.0	922.0	7.0	7.0
MW-23	13	13	86.0	97.0	7.0	7.0
MW-24	14	14	507.0	468.0	7.0	7.5
MW-25	13	14	428.0	739.0	7.0	7.0

*Specific conductance not measured due to interference to probe by fuel product.

[1] Temperature artificially elevated due to proximity of well to underground steam pipes.

[2] Litmus paper was used to measure pH because of interference to electric meter probe from fuel product.

SECTION 4

DISCUSSION OF RESULTS AND SIGNIFICANCE OF FINDINGS

4.1 SITE SUBSURFACE CONDITIONS

Based on a general review of the area geology and site-specific information obtained during this and the previous IRP Phase II investigation, an overview of the site geology was obtained. Generally, the entire area is underlain directly by permeable interbedded continental and nearshore marine sands and clays. A majority of the wells installed at the site are screened in these unconsolidated sediments. Groundwater was encountered 10 to 13 feet below ground surface except in wells where the water table was depressed by floating fuel product.

4.1.1 Soils

The area north of the Bulk Fuel Storage Area and south of South Run Creek where the fuel spill occurred and where this investigation was concentrated is underlain by fill that was placed to bring the low area next to South Run Creek up to grade with the Bulk Fuel Storage Area. Most of the fill is native soil; however, some layers of organic fill and fly ash sludges were noted (borings 4, 15, and 29). The fly ash is probably associated with the power plant to the west of the Bulk Fuel Storage Area. Just below the fill, at 13 to 15 feet, is a layer of organic soil and peat that appears to be the surface of the marsh area originally bordering South Run.

Wells MW-19 and MW-21 (see Figure 3-3) encountered a mixed fill including fly ash and asphalt from 0 to 10 feet and black sludge at about 10 to 12 feet. An organic peat layer was encountered at 9 to 11 feet in MW-18, MW-19, MW-21, and MW-22. This horizon was laden with fuel in MW-18, MW-19, and MW-21.

Unlike the sediments encountered north of the Bulk Fuel Storage Area, MW-24 to the east encountered clean, fine to coarse sands and gravels. Traces of fuel and elevated HNu readings were detected in these sediments. Upgradient wells MW-20 and MW-23 (see Figure 3-3) exhibited the typical lithology of interbedded sands and clays, and no traces of fuel were detected in these sediments. These sediments are part of the Cohansey Formation that directly underlies this area of the McGuire AFB (see Figure 2-1).

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4.1.2 Groundwater

Table 4-1 presents a summary of groundwater and surface water elevation data used to develop the groundwater surface contour map. Water level measurements for wells MW-17, MW-18, MW-19, and MW-21 were corrected for depression due to floating fuel product. These calculations and corrections are presented in Appendix F.

As evidenced by the water level measurements from MW-12, MW-13, and MW-18 through MW-25, groundwater occurs throughout the facility at shallow water table conditions in the unconsolidated sediments. The water table occurs generally less than 13 feet below ground surface. Figure 4-1 depicts a generalized groundwater surface contour map of the facility from data generated by monitor well water level measurements and surface water elevations from South Run. The direction of groundwater flow is generally perpendicular to the contour lines in the direction of decreasing elevation. There is a positive gradient of flow toward South Run which receives discharge from the groundwater table. There is also a component of flow to the east parallel to South Run and the regional direction of groundwater flow.

The horizontal gradient of flow was calculated along the flow line between wells MW-20 and MW-21. This is equal to the drop in head (3.35 feet) divided by the length of the flow line/distance (399 feet) between the two wells. It is expressed mathematically as:

$$i = \frac{\Delta h}{L}$$

where:

i = hydraulic gradient
Δh = change in head
L = length of flow

The Δh and L are expressed in units of length, such as feet, so that the hydraulic gradient is dimensionless. The hydraulic gradient was calculated as 0.008, or 3.35 feet of head loss (groundwater surface elevation) over a horizontal distance of approximately 400 feet.

Table 4-1

Summary of Monitor Well and Surface Elevation Survey in the Bulk Fuel Storage Area

Well	Depths to Water (feet) 4/2/85	Depths to Water (feet) 4/22/85	Elevation to Top of Casing (feet)	Groundwater Elevation (feet) 4/2/85	Groundwater Elevation (feet) 4/22/85	Fuel Product Thickness in Well (feet) 4/2/85	Fuel Product Thickness in Well (feet) 4/22/85	Corrected[2] Fuel Product Thickness (feet) 4/22/85
MW-12	16.95	17.25	111.30	---	97.4[1]	---	4.77	1.19
MW-13	---	11.38	109.73	---	98.4	---	ND	ND
MW-18	17.05	16.80	108.67	94.4[1]	99.3[1]	2.66	5.00	1.25
MW-19	17.75	17.80	110.24	95.4[1]	96.3[1]	4.33	5.67	1.42
MW-20	11.94	12.04	111.13	99.2	99.1	ND	ND	ND
MW-21	15.29	15.90	108.86	95.4[1]	96.5[1]	2.58	5.00	1.25
MW-22	12.53	12.52	105.04	92.5	92.5	ND	ND	ND
MW-23	13.44	13.40	108.62	95.2	95.2	ND	ND	ND
MW-24	14.74	14.78	108.00	93.3	93.2	Surface Fraction	Surface Fraction	Surface Fraction
MW-25	13.28	13.34	109.48	96.2	96.1	ND	ND	ND

[1]Water level corrected for depression due to floating product.
[2]The height of the product in the borehole will be approximately four times the true thickness of the product layer in the aquifer (dePastrovich, et al., 1979). See Appendix F for further discussion.

ND - Not detected

--- No measurement taken

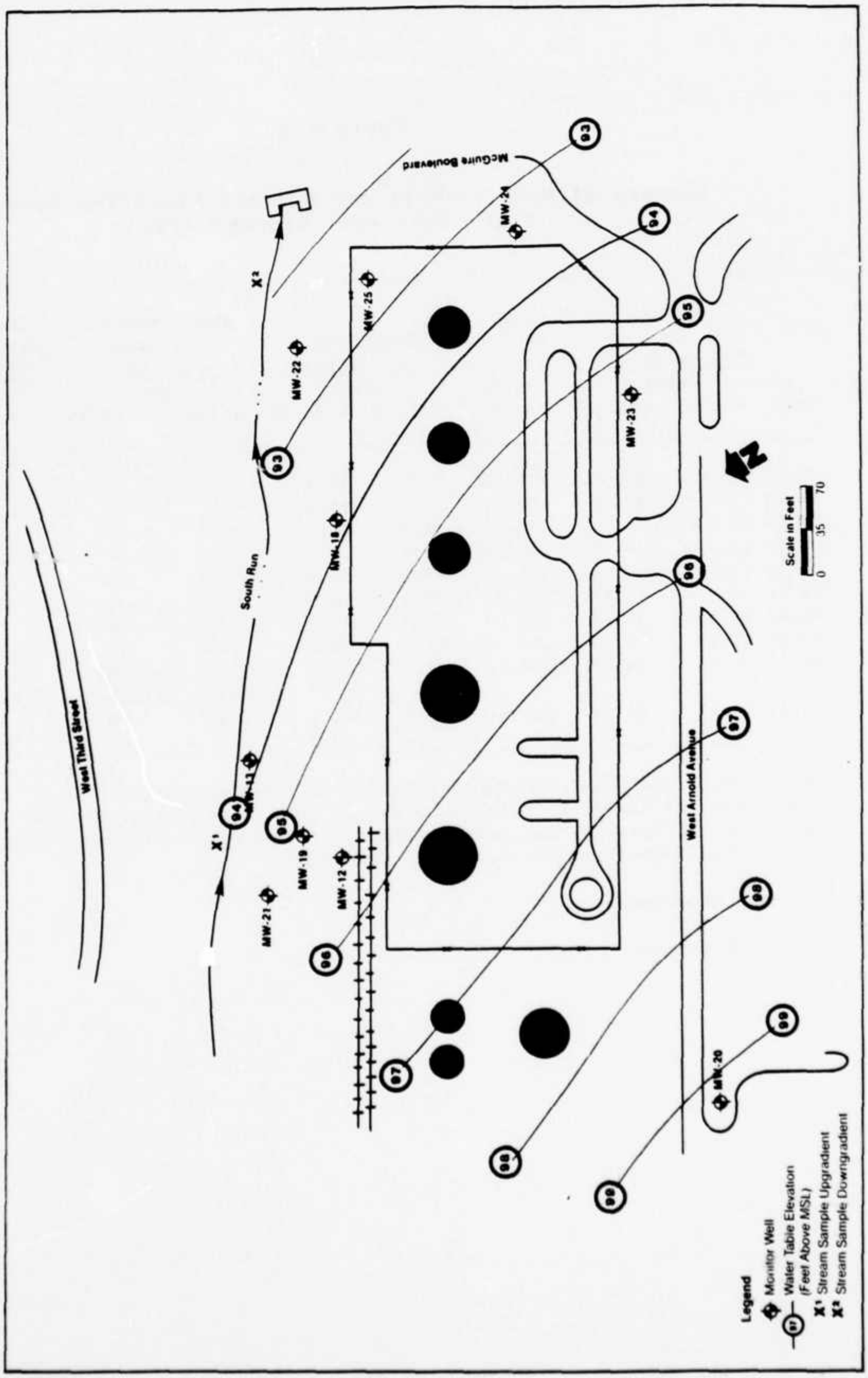

FIGURE 4-1 GENERAL SITE MAP OF THE BULK FUEL STORAGE AREA SHOWING GROUNDWATER CONTOURS McGUIRE AFB, NEW JERSEY

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The velocity of groundwater flow in this area (seepage velocity, V) was determined as a function of the hydraulic gradient, i, established from the groundwater elevation survey and the hydraulic conductivity, K, a factor established from the underlying sediments. The seepage velocity was calculated using the following relationship:

$$V = \frac{Ki}{n}$$

where:

V = seepage velocity
K = hydraulic conductivity
i = hydraulic gradient
n = porosity of the sediment

Porosity in sandy sediments varies over a narrow range and can be estimated at 0.3 without producing significant error. Hydraulic conductivity, the amount of water flowing through a unit area of aquifer under a hydraulic gradient of one, can be estimated from sediment type. Based on a hydraulic conductivity for fine sands of 8 feet per day (Todd, 1980), an estimate of groundwater velocity in the northern portion of the area may be calculated to be:

$$V = 8 \text{ ft/day} \times \frac{0.008}{0.3}$$

$$V = 0.21 \text{ ft/day} = 76.7 \text{ ft/yr}$$

In the eastern portion of the area, the gradient of flow in more permeable clean, fine to medium sands trends in an easterly direction. Using the aforementioned mathematical expressions, the hydraulic gradient, i, and seepage velocity, V, of the groundwater (for the flow between wells MW-20 and MW-24) were calculated:

$$i = \frac{\Delta h}{L}$$

$$i = \frac{2.77 \text{ ft}}{735 \text{ ft}}$$

$$i = 0.004$$

$V = \frac{Ki}{n} = 20$ ft[1]/day $\times \frac{0.004}{0.3} = 0.27$ ft/day

$V = 0.27$ ft/day

$V = 99$ ft/yr

The calculated seepage velocities for the two sediment types are not significantly different (77 versus 99 feet per year) because the gradients in the higher conductivity sands tend to be lower than gradients in the fine sands.

4.1.3 Fuel Product Distribution

Fuel product thickness was measured in the monitor wells using the methods described in Subsection 3.6.1. Product thicknesses in excess of 30 inches were measured in wells MW-12, MW-18, MW-19, and MW-21 (see Table 4-1). From these results and the results of product thickness measurements in temporary well points in test borings (see Table 3-3), it was determined that two individual plumes of fuel with significant thickness were floating on the groundwater. Figure 4-2 is a fuel product distribution map showing the location and areal extent of floating fuel product.

The largest plume of floating fuel was found in the vicinity of wells MW-12, MW-19 (formerly soil boring 25), and MW-21 (formerly soil boring 15). Floating fuel product was also observed in six temporary well points within the large plume boundary (soil borings 1, 6, 15, 16, 24, 25, and 26). No floating product was encountered in the temporary well points immediately surrounding the large plume.

The smaller plume of floating fuel was found in the area of MW-18 (formerly soil boring 6). None of the temporary well points within a 50-foot radius of the small plume (soil borings 5, 7, 8, 9, 10, 19, and 20) encountered any fuel product.

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[1]Groundwater Hydrology.

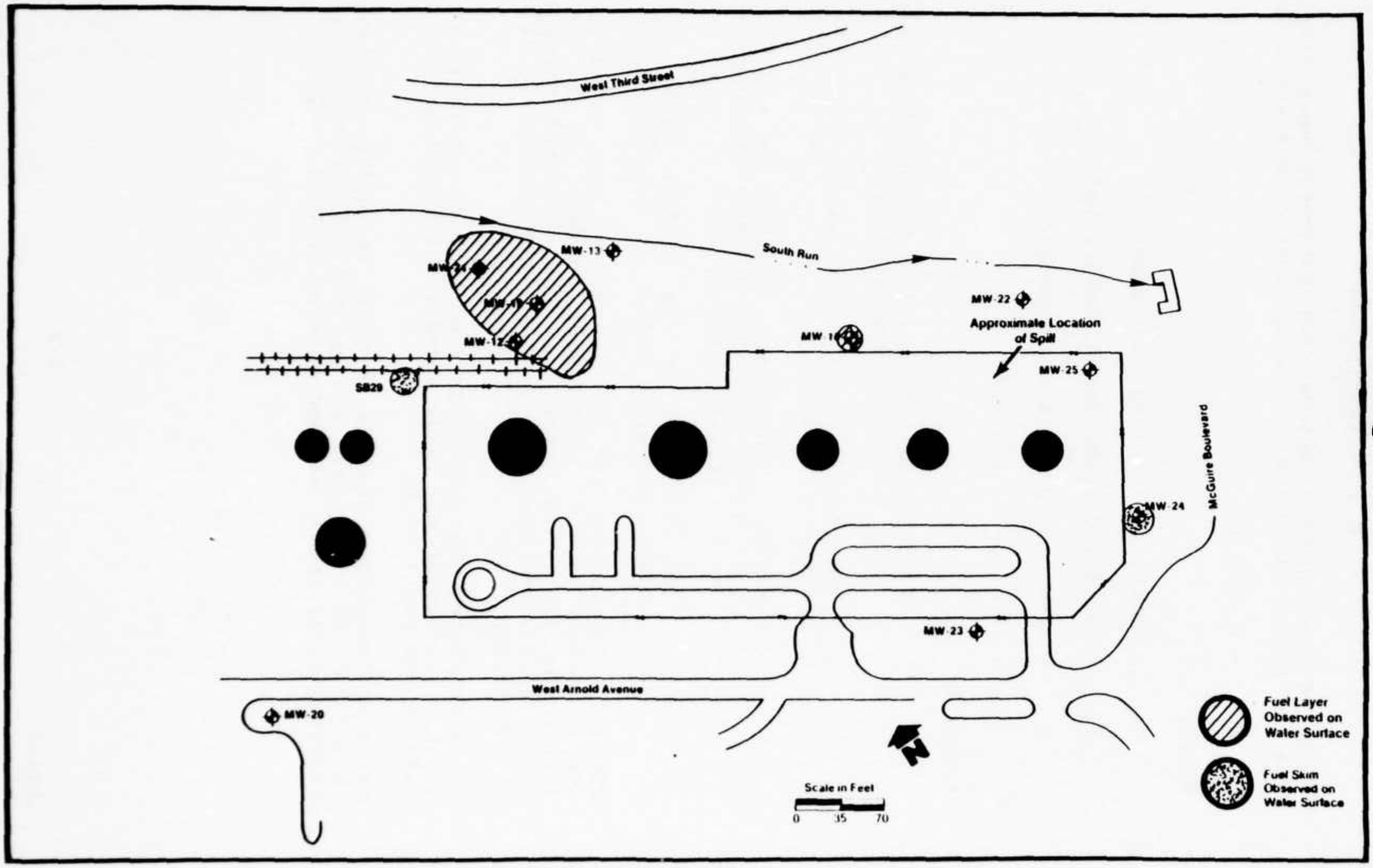

FIGURE 4-2 GENERAL SITE MAP OF THE BULK FUEL STORAGE AREA SHOWING FLOATING FUEL PRODUCT DISTRIBUTION MCGUIRE AFB, NEW JERSEY

Floating fuel product volume (V_f) estimates were computed for the two plumes using the following equation and assumptions:

$$V_f = T_p \times A \times n$$

Where:

V_f = Volume of floating fuel product

T_p = Corrected thickness of fuel layer

A = Area of plume (lateral extent)

n = Porosity of aquifer

assuming:

- Porosity is 0.25 for the dense medium sandy materials underlying the facility,
- Pore space is saturated within the thickness of the product layer,
- Product thicknesses measured in well bores are four times the true product thicknesses in the aquifer (see Appendix F), and
- The thickness of the product layer is uniform within the areal extent of the plume.

The fuel thicknesses for the two plumes were calculated using the corrected product thicknesses measured on 22 April 1985 (see Table 4-1). The average of the corrected thicknesses in MW-12, MW-19, and MW-21 was used for the volumetric calculation of the larger plume.

It is estimated that 29,833 gallons of fuel remain in the ground at the location of the large plume and 825 gallons remain in the area of the small plume.

While no measurable amounts of floating fuel product were found in any of the other soil boring and monitor wells, a surface fraction (oily sheen) was encountered in well MW-24.

4.2 ANALYTICAL RESULTS

4.2.1 Soil Analyses

Sixteen surface soil samples and 44 subsurface soil boring samples were analyzed at the WESTON laboratory for O&G compounds. The results of these analyses are presented in Tables 4-2 and 4-3, respectively. Complete laboratory reports are included in Appendix G. With the exception of surface soil sample No. 2 (see Figure 3-2) and subsurface soil sample SB-29 (see Figure 3-1), all the samples containing elevated O&G concentrations, above 0.5 microgram (ug)/g, were located within the fuel plume areas. Although concentrations varied with depth from 0 to 17 feet, a majority of the samples with the highest concentrations occurred below 5 feet. Sample SB-26 contained 12,000 ug/g, the highest level of O&G.

There are currently no quality standards, guidelines, or criteria for soil quality regarding O&G contaminants. For clean-up purposes, target concentrations for specific contaminants are usually established on a case-by-case basis by the regulatory agency having jurisdiction.

4.2.2 Water Quality Analyses

The results of the water quality analysis for O&G and BTX are presented in Table 4-4. Analytical results of the water samples collected during the first sampling event (2 April 1985) show elevated O&G and BTX in samples from downgradient wells MW-18, MW-19, MW-21, and MW-24. O&G concentrations ranged from 6.77 mg/L to 9,300 mg/L, the latter occurring in samples from MW-18. Well MW-21 exhibited the second highest O&G level at 667 mg/L; the third highest concentration (538 mg/L) was found in well MW-19. Wells MW-19 and MW-21 are located within the oil plume referenced in Subsection 4.1.3. O&G levels in the remaining four wells (MW-20, MW-22, MW-23, and MW-25) and two stream samples were slightly elevated, just above the detection limit of 0.10 mg/L, and are not considered anamolous.

BTX were present in association with those wells exhibiting high O&G concentrations. High levels of BTX were detected in samples from wells MW-18, MW-19, MW-21, and MW-24 as shown in Table 4-4.

The general distribution of O&G and BTX occurrence was consistent between sampling rounds, although concentrations were generally orders-of-magnitude lower for the second sampling round when compared to the results of the first sampling round. MW-12 and MW-13 were not sampled during the first sampling round. Results of the second round show that MW-12 had high O&G and BTX concentrations while MW-13 showed slightly elevated levels of toluene and xylenes; benzene was not detected.

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Table 4-2

Summary of Surface Soil Analyses for the Bulk Fuel Storage Area

Sample Reference[1]	Oil and Grease (ug/g)
01[2]	1,180
02	52
03	284
04	1,490
05	46
06	341
07	52
08	134
09	90
10	2,630
11	1,370
12	108
13	3,430
14	52
15	73
16	97

[1]Locations are shown in Figure 3-2.
[2]Representative samples from key locations were selected for analysis. Sample numbers are the order of selection, not the order of sampling.

Table 4-3

Summary of Subsurface Soil Analytical Results for the Bulk Fuel Storage Area

Soil Boring Sample*	Depth (feet)	Oil and Grease (ug/g)
SB-1	5-7	5,030
SB-1	10-12	1,650
SB-2	5-7	162
SB-2	10-12	43
SB-3	5-7	69
SB-3	10-12	7,780
SB-4	5-7	71
SB-4	10-12	39
SB-5	0-2	5,630
SB-5	5-7	245
SB-6	5-7	157
SB-6	10-12	245
SB-7	5-7	224
SB-8	7-9	157
SB-10	5-7	90
B-11	0-13	142
B-12	0-13	299
B-13	0-13	36
B-14	0-11	32
SB-14	11-13	130
SB-15	11-13	820
B-16	0-13	106
B-17	0-13	180
SB-18	0-2	306
B-18	5-13	96
B-19	0-13	47
B-20	0-11	114
B-21	0-11	67
B-22	0-11	172
B-23	0-13	39
SB-24	7-9	102
SB-24	11-13	566

*SB-# samples indicate individual samples.
B-# samples indicate composite samples.

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Table 4-3
(continued)

Soil Boring Sample*	Depth (feet)	Oil and Grease (ug/g)
SB-25	5-7	70
SB-25	9-11	9,170
SB-26	5-7	160
SB-26	9-11	12,000
B-27	0-11	102
SB-27	11-13	84
B-28	0-11	49
SB-29	5-7	26
SB-29	7-9	1,730
B-30	0-11	32
B-30	0-11 Dup	27
SB-30	11-13	184

*SB-# samples indicate individual samples.
B-# samples indicate composite samples.

Table 4-4

Summary of Water Analytical Results for the Bulk Fuel Storage Area

Location	Oil and Grease (mg/L) 4/2/85	Oil and Grease (mg/L) 4/24/85	Benzene (ug/L) 4/2/85	Benzene (ug/L) 4/24/85	Toluene (ug/L) 4/2/85	Toluene (ug/L) 4/24/85	Xylenes (ug/L) 4/2/85	Xylenes (ug/L) 4/24/85
MW-12	NS	105	NS	4,900	NS	6,000	NS	8,500
MW-13	NS	0.28	NS	ND	NS	3.0	NS	8.8
MW-18	9,300	793	320,000	6,000	310,000	14,000	1,100,000	24,000
MW-19	538	34.3	<50,000*	14,000	70,000	18,000	200,000	24,000
MW-20	0.26	0.30	ND	ND	ND	ND	ND	ND
MW-21	667	22.4	<50,000*	6,000	74,000	5,900	510,000	17,000
MW-22	0.26	0.10	ND	ND	ND	ND	11	ND
MW-23	0.24	0.15	ND	ND	ND	ND	ND	5.7
MW-24	6.77	4.44	2,200	3,500	2,100	130	19,000	6,000
MW-25	0.56	0.40	ND	ND	ND	ND	ND	ND
Field blank	0.10	0.10	ND	ND	ND	ND	ND	ND
Trip blank	0.12	---	ND	ND	ND	ND	ND	ND
Duplicate	---	0.27 (MW-20)	ND (MW-25)	ND (MW-20)	ND (MW-25)	ND (MW-20)	ND (MW-25)	ND (MW-20)
Station 1 (up-gradient)	0.30	NS	ND	NS	ND	NS	ND	NS
Station 2 (down-gradient)	0.37	NS	ND	NS	ND	NS	ND	NS
Detection Limit	0.1	0.1	2.0	2.0	2.0	2.0	4.0	4.0

NS - Not sampled
ND - Not detected
--- No Measurement taken

*Large interference eluting near benzene making detection and quantification of benzene impossible.

The probable explanation for the difference between first round and second round analytical results for MW-18, MW-19, and MW-21 is related to the purging and consequent mixing of the fluid in these wells containing several feet of floating fuel product. The amount of fuel product that was purged from the wells and the amount that was mixed with the groundwater is probably not reproducible and varied, therefore, between the two sampling rounds. This resulted in one set of samples (the first sampling round) with a much greater amount of emulsified fuel product in the samples. Results did not vary so significantly at MW-24 where only traces of free fuel were observed on the water surface prior to purging. These results indicate that representative samples of wells where two phases are present may be better accomplished by selective sampling of discrete points in the column prior to purging.

Relatively low levels of xylenes and/or toluene were found in wells MW-13, MW-22, and MW-23 (see Table 4-4). BTX concentrations in samples from MW-20, MW-25, and surface water were below detection limits.

4.3 SIGNIFICANCE OF FINDINGS

4.3.1 Groundwater

The investigation at the Bulk Fuel Storage Area focused on three aspects of subsurface contamination by fuel products: visible contamination of subsoils, migration of fuel product on the groundwater surface, and the migration of dissolved constituents in the groundwater. As a result of the field investigation, four principal areas of groundwater contamination were identified:

- Along the northern boundary of the area in the vicinity of wells MW-12, MW-19, and MW-21 where the overland flow of fuel collected and subsequently percolated into the water table.

- Along the northern boundary of the area in the vicinity of well MW-18 where the leaks occurred in the standpipes.

- Along the eastern boundary of the area in the vicinity of well MW-24 where high levels of dissolved constituents were detected.

- Outside the northwestern corner of the area fence boundary in the vicinity of soil boring 29.

These four areas are shown in Figure 4-2.

The major occurrence of fuel product in the groundwater is concentrated in the two areas north of the Bulk Fuel Storage Area around wells MW-12, MW-19, MW-21, and MW-18 (see Figure 4-2). The extent of the plume is limited, and there is no evidence of seepage into South Run at this time. Fuel product is readily recovered from the above wells by pumping or bailing.

There is evidence of a plume of dissolved constituents to the east of the Bulk Fuel Storage Area (MW-24). This plume probably is not associated with the recent fuel spill, and its extent has not been defined.

Evidence from the field investigation and information from base personnel indicate that the two major plumes of free fuel product resulted from the single fuel spill event that originated near MW-18. Fuels migrated through the railroad bed (functioning as a conduit for preferential surface flow) from the source to the vicinity of MW-12 and MW-19. It is suspected that fuels were diffused to the surrounding soils and subsequently to the groundwater through the loosely compacted backfill of the storm drain entrenchment that crosses the site in this area.

The discharge area for the groundwater north of the area is South Run. Based on the seepage velocity for groundwater in this area (77 ft/yr), groundwater and associated contaminants (i.e., BTX) should have already entered South Run. However, based on field observations and laboratory analyses, this does not appear to be the case. This may be a response to the following conditions:

- The existence of an impermeable or semipermeable unit between the contaminant plumes and South Run that restricts lateral flow. Since the spill area is extensively backfilled to the edge of South Run Creek, this barrier may be a natural or man-made levee of silt and clay soils adjacent South Run Creek and presently obscured by the backfill.

- The complex characteristics of underlying sediments (mixed fill and interbedded sands and clay) retarding migration due to permeable strata pinching out.

Although the lateral extent of free floating fuels on groundwater is limited, the fuels provide a constant supply of dissolved constituents to the groundwater system. The migration potential for these compounds is close to the seepage velocity of the groundwater itself.

In the eastern portion of the site there exists a potential for off-site migration of dissolved groundwater contaminants encountered in well MW-24. There is no evidence that the migration of these constituents is limited to or contained to the east of the site. The extent of contaminant migration cannot be quantified since this source was found in the outer fringes downgradient of the study area. In order to conclusively determine the extent of migration, additional field investigations pertinent to the source would be necessary.

4.3.2 Soils

Elevated levels of O&G in unsaturated soils occur in the same areas as fuel occurrence in the groundwater with some exceptions such as boring 29 area. Fuel in these soils is flushed to the groundwater by precipitation percolating through the soils and provides some recharge to the plume.

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SECTION 5

ALTERNATIVE MEASURES

5.1 INTRODUCTION

The soils and groundwater at the McGuire Air Force Base site have been impacted with hydrocarbons as a result of the April 1984 JP-4 fuel spill. The data obtained from a program of soil borings and sampling of soils, surface water, and groundwater revealed that hydrocarbons associated with the JP-4 spill in April 1984 primarily impacted soils and groundwater in the north and northeast portions of the Bulk Fuel Storage Area. In particular, floating JP-4 fuel on the groundwater was found in monitor wells MW-12, MW-19, MW-21, and MW-18 and appeared to be limited to the local area. Measurements in the monitor wells indicated a 1- to 2-foot layer of floating hydrocarbons (corrected product layer thickness) in the area of wells MW-12, MW-19, MW-21, and MW-18 (see Figure 4-2).

The investigation of surface water revealed no seepage of hydrocarbons to South Run. In addition, BTX analyses on groundwater samples indicated that the spill plume was limited in extent. The plume of dissolved constituents associated with BTX concentrations in MW-24 was downgradient of the Bulk Fuel Storage Area, and its extent cannot be determined from the available data. Further study is needed to determine the source and the extent of that plume which does not appear to be related to the 1984 spill. This issue is beyond the scope of this study and will be addressed in the IRP Phase II Stage 2 Report for McGuire AFB. This document contains a detailed discussion of the Remedial Investigation necessary in the Bulk Fuel Storage Area. This includes full consideration of the fuel spill accident, leakage through the sludge pits, and past fuel leaks to the soil.

5.1.1 Purpose

This subsection develops potential alternatives for addressing the restoration of soils and groundwater impacted by the aforementioned JP-4 fuel spill. In addition, preliminary evaluation of the applicability of these alternatives at the site has been provided. Also, further data needs have been identified to facilitate a further analysis of the applicability of these alternatives during the next phase of work.

Each alternative has been conceptually developed to describe the application of component technologies. In addition, each immediate response alternative has been evaluated on the basis of technical feasibility, cost-effectiveness, implementation time frame, and environmental effectiveness.

5.1.2 Approach

In view of the fuel spill volume and the relatively low mobility of the floating fuel product, a two-phase approach for site remediation has been developed. The first phase addresses the short-term concerns at the site and proposes the recovery of the floating JP-4 fuel from the groundwater table. The second phase involves long-term remediation measures to address the potentially dissolved hydrocarbon constituents in groundwater and hydrocarbons associated with soils. Further development of this approach is provided in subsequent portions of this subsection.

5.2 SHORT-TERM RESPONSE ALTERNATIVES

The short-term response alternatives have been designed to achieve the following goals:

- Facilitate the recovery of floating hydrocarbons from the groundwater table.
- Provide containment and minimize the potential of subsurface discharge of floating hydrocarbons to South Run.
- Allow for immediate and economical implementation of the remediation alternative with minimal maintenance during the operation.

Three alternatives have been developed for immediate remedial action at the site of the JP-4 release. These alternatives include:

- Installation of an interception trench with pump recovery systems for the floating hydrocarbons.
- Installation of low-production pumping systems in monitor wells to selectively remove floating hydrocarbons.
- No action.

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5.2.1 Interception Trench with Pump Recovery Systems

This alternative is an in situ approach to remove the floating hydrocarbons from the groundwater table. A gravel-filled trench will be installed to a depth of about 2 feet below the water table (i.e., approximately 14 to 15 feet deep) to intercept the potentially migrating floating hydrocarbons. This trench will be graded so that the sumps located in the trench can collect the floating hydrocarbons. Pumping systems will be installed in the sumps such that the floating hydrocarbons are removed with a minimal amount of associated groundwater on a demand basis. The approximate location of the trench is shown in Figure 5-1. The exact size and extent of the trench will need to be verified as part of the predesign activities. This location has been selected to facilitate the interception of the projected flow path of the floating hydrocarbons and, thereby, maximize the recovery of the hydrocarbons. The following steps must be undertaken to implement this remediation alternative:

- Excavation of the sump and trench as shown in Figure 5-1. The width of the trench in Figure 5-1 considers the need to cut a backslope in lieu of shoring.
- Application of a synthetic liner to the bottom and downgradient side of the trench.
- Application of a geogrid for slope stability and to prevent clogging of the trench with fine grained materials.
- Backfilling of the trench with gravel and installation of a cover system.
- If required, backfilling and grout-sealing of the trench when the hydrocarbon recovery operations at the trench are terminated.

The cost of implementing this alternative, excluding operating and maintenance costs and disposal costs for excavated soils, is estimated at $30,000.

The advantages of this remedial alternative include:

- The initial capital cost and operating and maintenance costs are relatively low.
- The trench is essentially a passive system requiring little or no maintenance except for the pumping system.

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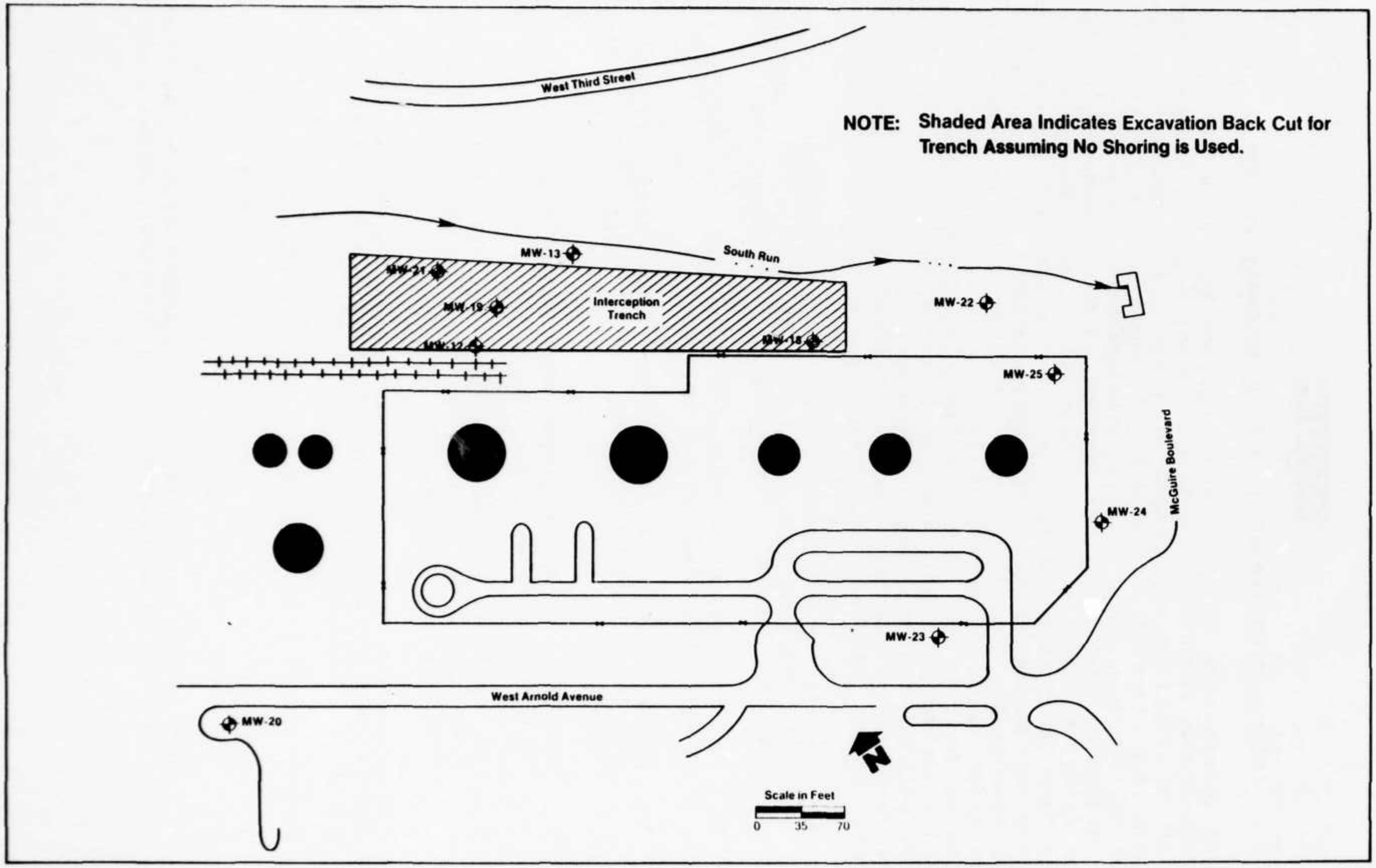

FIGURE 5-1 LOCATION OF PROPOSED INTERCEPTION TRENCH
McGUIRE AFB, NEW JERSEY

The disadvantages of the alternative include:

- Potential disruption of monitor wells (MW-12, MW-19, MW-21, and MW-18).
- Limited space conditions leading to construction of steep slopes in the trench in some areas.
- Removal of large quantities of soil and stockpiling on-site for future disposal.
- Potential removal of the inactive piping system and disruption of a portion of the railroad tracks.
- Potential fire hazard associated with the excavation and installation of the interception trench.

5.2.2 Recovery Using Low-Production Pumping Systems in Monitor Wells

This alternative is an in situ approach wherein the existing monitor wells (e.g., MW-12, MW-19, MW-21, and MW-18) or additional larger wells may be used for recovering the floating hydrocarbons. A low-production (intermittent) pumping system should be sufficient to maintain drawdown in the recovery wells due to the hydrogeologic character of the aquifer (i.e., fine grained and relatively thin). The recovery of the floating hydrocarbons will be facilitated by using low-production pumping systems, e.g., the automatic bailing system or the jack pump system. The automatic bailing and jack pump systems are amenable to selectively removing floating hydrocarbons in groundwater.

The advantages of this remediation alternative include the following:

- The recovery system will require little or no maintenance.
- The initial capital cost and operating costs are relatively low.
- No disruption to existing structures or any ongoing activities at the site.

- No removal of any soils or earthmoving activity at the site and no disposal of debris.

There are some disadvantages to this alternative and these include:

- The system may not provide long-term protection against migration of any future spilled material.
- The recovery may be slower than the interception trench recovery system.
- The system may not provide the same degree of effective containment as the interception trench system.

5.2.3 No Action

This action will not involve the implementation of a containment and recovery system for the floating hydrocarbons from the groundwater table. A periodic monitoring and sampling program will be implemented to track potential migration of the floating hydrocarbons in the groundwater table.

The costs associated with the no action alternative include the following:

- The cost for periodic monitoring and sampling.
- The value of the JP-4 fuel that is not recovered.
- The cost of potential environmental damage that may be caused by the presence of floating hydrocarbons in the water table and their potential discharge to South Run.

The quantity of JP-4 fuel present as floating hydrocarbons in the groundwater that can be recovered cannot be estimated at this time. The field investigation studies revealed that the plume of floating hydrocarbons in the groundwater is limited in extent; however, the presence of floating hydrocarbons in the groundwater, the proximity of South Run to the plume location, and the local north/northeasterly flow of groundwater in the water table present a potential for future release of the floating hydrocarbons into South Run. If such a release occurred, the costs of cleanup and recovery of the hydrocarbons would be at least an order of magnitude higher than the costs of implementing an immediate response remediation measure.

5.2.4 Evaluation of Immediate Response Alternatives

In view of the substantial quantity of floating hydrocarbons in the groundwater, the proximity of South Run to the spill site and the plume of floating hydrocarbons, and the localized groundwater flow direction toward South Run, the no action alternative is considered unacceptable.

The interceptor trench recovery and low-production pump recovery from monitor wells involve selective removal of floating hydrocarbons from the groundwater. These systems have been widely used in petroleum refineries and fuel terminals in response to similar spill impact situations. Although the collection/recovery systems vary widely in configuration based on site conditions, this practice has been widely accepted by regulatory agencies as a fundamentally sound approach for recovery of floating fuels from groundwater. Both of the abovementioned systems facilitate the recovery of floating hydrocarbons with minimal withdrawal of groundwater.

The interception trench recovery system will provide more effective containment, faster recovery, and long-term usage potential as compared to the low-production pump recovery from monitor wells. However, the interception trench recovery system will involve higher initial capital and installation costs and result in removal of large quantities of soil (which will be stockpiled on-site and subsequently disposed), potential disruption of monitor wells, steep slopes in the trench due to limited space availability, and a potential fire hazard during excavation and installation. On the other hand, recovery of floating hydrocarbons from monitor wells using low-production pumping systems will involve the use of existing structures on-site with no additional major construction or earthmoving work on-site.

5.3 LONG-TERM REMEDIAL ALTERNATIVES

The remedial alternatives developed in this subsection are designed to address the long-term remediation of the soils and groundwater impacted by the April 1984 JP-4 fuel spill at the site. Long-term remediation alternatives for other problems associated with the Bulk Fuel Storage Area will be discussed in the IRP Phase II Stage 2 Report for McGuire AFB. In developing these alternatives it has been assumed that the floating hydrocarbons have been removed and that the groundwater contains dissolved JP-4 hydrocarbons constituents and fugitive quantities of floating hydrocarbons. The cleanup standards and criteria have not been defined at this site. A definition of applicable cleanup standards and criteria and a detailed evaluation of the alternatives will be provided in the next phase of work.

5.3.1 Soil Restoration Alternatives

Based on the results of the field investigations in the spill area, the following remediation alternatives have been identified for addressing the restoration of soils impacted by the JP-4 spill in April 1984. These alternatives include:

- No action.
- Devolatilization/aeration of soils.
- Land treatment.
- On-site encapsulation.
- Installation of an impermeable cap system.
- Off-site disposal.

5.3.1.1 No Action

This alternative serves as a baseline for comparison and includes periodic monitoring and sampling of the monitor wells and South Run.

5.3.1.2 Devolatilization/Aeration of Soils

The devolatilization/aeration of soils is a treatment technique involving the removal of volatile hydrocarbons from soils by stripping with a gaseous medium, usually air. The devolatization/aeration of soils can be performed in two modes:

- In situ.
- Removal of soils followed by mechanical aeration.

The in situ devolatilization/aeration of soils is accomplished through installation of a system of perforated wells in the area of concern followed by forcing or drawing of air through the perforated well system. The effluent air from the system requires monitoring and may have to be treated prior to discharge depending on the concentrati ns of hydrocarbons in the effluent air stream and the emission standards.

The Fuel Recovery Company of St. Paul, Minnesota, markets a patented "Interceptor Vent System." This system is comprised of perforated pipe wells set into the soils and attached to a large suction pump. The pump draws a small vacuum that induces volatilization of the hydrocarbons constituents in soils. The effluent can be drawn and vented to the atmosphere through a smoke stack or through an activated carbon filter. This system has been used in Minnesota for removal of volatile residuals in soils and has been approved by that State's regulatory agency for such applications.

Roy F. Weston, Inc. has performed field pilot studies for removal of volatile organics in soils by the devolatilization treatment technique. A system of perforated vent wells and a blower to force air through the soils was utilized to achieve the devolatilization.

The advantages of the in situ devolatilization/aeration treatment include the following:

- Minimal disruption of site conditions and operations during the remedial action.
- Removal of volatile fraction of JP-4 fuel constituents in the soil.
- Relatively low cost.
- Convenient treatment of the effluent since it occurs as a point discharge.

The disadvantages of the system include:

- Long period of operation.
- The nonvolatile constituents of the JP-4 fuel would continue to remain in the soil zones.

The second mode of aeration of soils involves the excavation of soils and subsequent aeration through mechanical means. This mode of aeration of soils would be performed as follows:

- Excavation of soils and stockpiling.
- Mechanical mixing of soils using rotating trommels, screens, pug mill type mixers, or other similar mechanical mixing equipment.
- Enhanced stripping through utilization of a system of blowers.
- Sampling of treated soils to determine residual concentrations of hydrocarbons.
- Continuous air monitoring at the site.
- Backfilling of the excavated areas with treated soils.

The advantages of the system include the following:

- Treatment accomplished on-site and the treated soils can be backfilled.
- Removal of the volatile fraction of JP-4 fuel constituents in the soil.
- Potentially higher efficiency of removal as compared to in situ devolatilization/aeration.
- Shorter period of operation as compared to in situ devolatization.

The disadvantages of the system include the following:

- Relatively higher costs.
- Extensive handling of soils (excavation, stockpiling, processing, and backfilling).
- Potential for uncontrolled air releases, thereby requiring continuous air monitoring.
- State-of-the-art technology, thereby requiring bench-scale studies and possibly pilot-scale studies to establish process parameters (e.g., residence time, throughput, air flow rates) and operational methodologies.

5.3.1.3 Land Treatment

Land treatment is a source control measure that involves spreading of soils in thin layers (6 to 12 inches) followed by soil cultivation. The cultivation of applied soils may be performed with agricultural equipment including disc harrows, rakes, or plows.

In view of the chemical and biodegradable properties of the hydrocarbon constituents of the JP-4 fuel, the land treatment of the hydrocarbon impregnated soils at the site will be achieved through two mechanisms -- biological degradation and volatilization of the volatile fraction of the hydrocarbons.

The implementation of the land treatment alternative will involve the following steps:

- Selection of a suitable land treatment site.
- Preparation of the site to establish drainage controls.
- Excavation of the impacted soils and subsequent landspreading in 6- to 12-inch layers at the land treatment site.
- Cultivation of the soils for an appropriate duration of time (usually a few days to a week).
- Sampling and analysis of the treated soils to determine if treatment standards have been achieved.
- Backfilling of the treated soils at the excavation site, regrading and restoration, if necessary.
- Continuous air monitoring for releases of volatile organic compounds at the site during excavation, landspreading, and cultivation.
- Compliance with the applicable Federal/State/local regulations for land treatment.

The advantages of this remediation alternative include the following:

- The technology has been successfully used by the petroleum industry.
- Moderate costs.
- Treated soils may be backfilled at the original excavation area.
- More effective treatment as compared to devolatilization/aeration since nonvolatile constituents of JP-4 fuel in the excavated soils can be biodegraded.

The disadvantages of the alternative include:

- Detrimental impact of wet and cold weather on the effectiveness and rate of biodegradation of the hydrocarbons constituents.

- Potential uncontrolled releases of volatile organic compounds during material handling and treatment operations.

- Potential temporary disruption of site work near the Bulk Fuel Storage Area.

5.3.1.4 On-Site Encapsulation

Encapsulation is a source control measure that would provide containment of the hydrocarbon constituents through the emplacement of hydrocarbon impacted soils in a specially designed cell. In addition, this alternative will include monitoring of the effectiveness of containment provided by the encapsulated cell through a long-term groundwater monitoring program.

The implementation of this alternative includes the following steps:

- Selection of an area on McGuire Air Force Base for construction of the encapsulation cell.

- Design of the encapsulation cell (including identification and installation of the liner material) in accordance with the Federal/State/local regulations.

- Design and construction of an impermeable cap system for the encapsulation cell.

- Removal of hydrocarbons-impacted soils and their placement in the cell.

- Development and implementation of a post-closure groundwater monitoring program.

- Establishment of an inspection and maintenance program for the final cap system.

- Establishment of vegetation cover and drainage controls.

- Installation of a perimeter fence to provide additional security.

- Backfilling of excavated areas at the spill site.

- Continuous air monitoring for volatile hydrocarbons during construction and installation.

The advantages of this alternative include:

- On-site disposition of the hydrocarbons-impacted soils.

- Relatively short time period for implementation of the alternative as compared to in situ operations and land treatment.

The disadvantages of the system include:

- Long-term post-closure monitoring involving regular groundwater monitoring, site inspections, mowing/maintenance of vegetation, and repair of erosion damage to the cover system.

- High initial construction and installation costs.

- Handling of hydrocarbons-impregnated soils.

- Potential for uncontrolled releases of volatile organic compounds during soil handling operations.

5.3.1.5 Installation of Cap System

This remedial alternative represents another source control measure which includes the construction of an impermeable cover system to prevent/minimize infiltration of water through the hydrocarbons-impacted soils.

The cap system may be constructed with clay materials or synthetic membranes. The two potentially applicable designs are described below:

- A multilayer clay cap system:

  - A 2-foot layer of compacted low-permeability clay material.

- A load-bearing geotextile fabric.
- A 6-inch drainage layer of sand and gravel.
- A filter fabric layer.
- A 6-inch layer of topsoil for seeding and vegetation.

• A multilayer synthetic liner cap system:

- A 1-foot layer of well-graded native soils.
- A 40-mil synthetic membrane.
- A 6-inch drainage layer of sand.
- A filter fabric layer.
- A 6-inch layer of topsoil for seeding and vegetation.

The cap system will be designed with a 3 to 5 percent slope to facilitate drainage of water to the collection channels constructed around the cap system.

The clay layer and synthetic membrane will function as impermeable barriers, thereby, preventing/minimizing the infiltration of water into the hydrocarbons-impregnated soils. The 6-inch sand drainage layer will facilitate the collection and flow of water to the collection channels around the cap system.

In addition, this alternative may require a long-term groundwater monitoring program and an inspection/maintenance program for the cap system. A perimeter fence may be required to provide additional security.

The advantages of the cap system include:

• No excavation nor handling of hydrocarbons-impregnated soils.

• No potential for releases of volatile hydrocarbons.

• Lower capital and installation costs as compared to encapsulation.

- Shorter construction and installation period as compared to in situ operations, encapsulation, and land treatment.

The disadvantages of this alternative include:

- Potential long-term monitoring of groundwater and inspection/maintenance of the cap system.

- Potential long-term restriction to use and access to the capped area for site activities.

5.3.1.6 Off-Site Disposal

This alternative involves the excavation of spill-impacted soils and disposal at an approved off-site facility.

Initially, the excavated soils would be stockpiled in small lots (typically 100 cubic yards), sampled, and analyzed for disposal purposes. Subsequently, the stockpiled material will be loaded into lined trucks and transported to an approved off-site disposal facility with appropriate placarding, stripping, or manifesting requirements. The excavated area will be backfilled with clean fill, regraded, and restored. In addition, a continuous air monitoring program will be implemented during active site operations.

The advantages of this alternative include the following:

- Use of standard construction, excavation, and earth-moving equipment and techniques for handling of soils.

- Existing permitted disposal facilities are within a reasonable distance of the base.

- No post-closure monitoring or maintenance requirements.

- No special permit requirements from Federal/State/local agencies.

- No restriction on the future land use of the excavated areas.

- Relatively short schedule for implementation.

The disadvantages of the alternative include:

- Potential for uncontrolled release of volatile hydrocarbons during material handling activities.
- High costs for disposal of the soils.

5.3.2 GROUNDWATER RESTORATION ALTERNATIVES

The groundwater restoration alternatives identified in this subsection have been designed to address long-term remediation of groundwater at the spill site. In developing these alternatives it has been assumed that floating hydrocarbons have been removed during the immediate response remediation work and that only fugitive quantities of floating hydrocarbons and dissolved hydrocarbons constituents are present in the groundwater.

Prior to implementation of the long-term groundwater restoration alternative, the following activities should be conducted:

- Definition of the plume of dissolved hydrocarbons constituents in groundwater, especially toward the eastern and southeastern areas of the Bulk Fuel Storage Area.
- Definition of the hydrocarbons constituents in soils at the eastern and southeastern area of the Bulk Fuel Storage Area.

These determinations can be accomplished as part of the larger base-wide IRP effort that will consider multiple sources of contamination in the vicinity of the Bulk Fuel Storage Area.

The following alternatives have been identified for groundwater restoration work at McGuire Air Force Base:

- No action.
- Groundwater pumping and treatment/disposal of the pumped groundwater.

5.3.2.1 No Action

The no-action alternative includes periodic monitoring and sampling of groundwater and surface water (South Run) to track potential migration and/or in situ attenuation (if any) of the groundwater. The available analytical information does not facilitate an objective evaluation of this alternative for long-term considerations. An adequate evaluation of this alternative can be made through sampling and analysis of the groundwater upon completion of the immediate response cleanup activities, determination of the plume of dissolved hydrocarbons constituents, and establishment of criteria and standards for hydrocarbons constituents in groundwater at the site.

5.3.2.2 Groundwater Pumping and Treatment/Disposal of Water

The pumping of groundwater with subsequent treatment/disposal constitutes an active treatment system. The groundwater would be pumped from selected points to create a cone of depression, thereby inducing the movement of the plume toward the collection points. The pumped groundwater would be treated prior to its disposition or shipped off-site in tankers for disposal. A typical approach to on-site treatment of the pumped groundwater would involve passing the water through an oil-water separator to remove the small quantities of floating hydrocarbons followed by discharge into the on-site treatment plant. If the groundwater cannot be treated at an on-site treatment system, an independent treatment system consisting of aeration units and carbon adsorption can be constructed and used on-site.

The aforementioned groundwater restoration program typically involves pumping of large quantities of water and long-term operation and maintenance of the pumping and treatment systems. With the volatility of the JP-4 fuel and low lower explosive limits (1 to 3 percent in air), a potential for creating explosive atmospheres exists during the treatment operations. In addition, State/Federal permitting requirements for treatment and point discharge will need to be addressed.

SECTION 6

RECOMMENDATIONS

6.1 INTRODUCTION

Based on the findings of the field investigation and the identification and preliminary evaluation of remedial alternatives, WESTON recommends a three-step approach for a site restoration program to remediate the impact of the April 1984 fuel spill.

- Implementation of an immediate response alternative to recover the floating hydrocarbons.
- Identify additional data needs involving the characterization of contaminant sources other than the fuel spill and further investigation of and definition of the plume of dissolved constituents at the eastern and southeastern portions of the Bulk Fuel Storage Area (MW-24).
- Analysis of the long-term alternatives after immediate response measures have been completed.

6.2 IMPLEMENTATION OF IMMEDIATE RESPONSE ALTERNATIVE

WESTON recommends the alternative involving recovery of floating hydrocarbons from the groundwater using low-production pumping systems installed in the existing monitor wells or additionally constructed recovery wells. In addition, the recovery operations should be supplemented by a periodic monitoring and sampling program in monitor wells MW-12, MW-13, MW-18, MW-19, MW-21, MW-22, and South Run Creek to monitor the efficiency of the recovery operation and the potential migration of hydrocarbons to South Run Creek.

This recovery system is recommended for the following reasons:

- The initial capital and installation costs are low with minimal or no maintenance requirements.
- No disruption to existing inactive piping system, railroad tracks, and ongoing activities around the Bulk Fuel Storage Area is involved.
- Existing systems (monitor wells) can be utilized to facilitate the recovery operation.

- Negligible, if any, potential for releases of volatile hydrocarbons into the atmosphere.

- Minimal, if any, physical handling of materials on-site and no earthmoving activities.

- On-site McGuire Air Force Base personnel can directly monitor, inspect, and operate the recovery system.

- Due to the hydraulic characteristics of the aquifers, the system should produce sufficient drawdown in the spill area to contain the floating contaminants.

After implementation, the system will be evaluated for general performance and efficiency.

6.3 ADDITIONAL DATA NEEDS

The additional data needs identified include:

- Definition of the plume of dissolved hydrocarbons constituents in groundwater towards the eastern and southeastern areas of the Bulk Fuel Storage Area (MW-24).

- Definition of hydrocarbons constituents in soils east and southeast of the Bulk Fuel Storage Area (MW-24).

- Additional sediment and surface water sampling of South Run.

- Development of cleanup standards and criteria for long-term remediation actions.

- Identification of other sources of dissolved hydrocarbons to groundwater (to be addressed in the IRP Phase II Stage 2 Report for McGuire AFB).

The definition of the groundwater contaminant plumes and hydrocarbons constituents in the soils will be addressed as part of the larger base-wide IRP effort that will consider multiple sources of contamination in the vicinity of the Bulk Fuel Storage Area. The Phase II Stage 2 report for the base presents a proposed course of action including additional data collection at the Bulk Fuel Storage Area.

6.4 ANALYSIS OF LONG-TERM ALTERNATIVES

Upon completion of the immediate response activities involving recovery of floating hydrocarbons, the monitor wells should be sampled and analyzed to determine the concentrations and extent of dissolved hydrocarbons in groundwater and the presence of any residual floating hydrocarbons. In view of this analytical data and the cleanup criteria and standards for long-term remediation, the long-term alternatives should be re-evaluated for technical feasibility, cost-effectiveness, implementation time frame, environmental effectiveness, and capability of implementation and operation using base manpower resources.

APPENDIX A

ACRONYMS, DEFINITIONS, NOMENCLATURE, AND UNITS OF MEASUREMENT

WESTON

APPENDIX A

ACRONYMS, DEFINITIONS, NOMENCLATURE, AND UNITS OF MEASUREMENT

AF	Air Force
AFB	Air Force Base
bldg.	Building
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DCE	Dichloroethylene
diabase	An intrusive igneous rock characterized by high iron and magnesium content
DOD	Department of Defense
EPA	Environmental Protection Agency
°C	Degrees Centigrade
°F	Degrees Fahrenheit
ft	Feet
gpd	Gallons per day
gpm	Gallons per minute
HIA	Harrisburg International Airport
McGAFB	McGuire Air Force Base
mo	Month
MSL	Mean sea level
No.	Number
USAFOEHL	United States Air Force Occupational and Environmental Health Laboratory

PADER	Pennsylvania Department of Environmental Resources
POL	Petroleum, oil, and lubricants
ppb	Parts per billion
ppm	Parts per million
RCRA	Resource Conservation and Recovery Act of 1976
SCS	Soil Conservation Service
sill	An intrusive body of igneous rock of approximately uniform thickness and relatively thin compared with its lateral extent, which has been emplaced parallel to the bedding of the intruded rock
sq ft	Square feet
sq mi	Square mile
TCE	Trichloroethylene
ug/kg	Micrograms per kilogram (equivalent to parts per billion)
ug/L	Micrograms per liter (equivalent to parts per million)
USAF	United States Air Force
USDA	United States Department of Agriculture
U.S. EPA	United States Environmental Protection Agency
VOA	Volatile organic aromatics

WESTON

APPENDIX B

TASK ORDER 3

1670H

gw

18 JUL 1985

REVISION 1
INSTALLATION RESTORATION PROGRAM
Phase II Stage 2
McGuire AFB NJ *

I. Description of Work

The purpose of this task is to determine the concentration gradient of fuels in soils and groundwater resulting from a JP-4 fuel spill at a former railroad off-loading facility at McGuire AFB NJ; to identify potential environmental consequences of migrating pollutants; to determine the magnitude, extent, and direction of movement of migrating pollutants; and to evaluate remedial alternatives to control further migration of contaminants and lead to clean-up of the area.

Ambient air monitoring of hazardous and/or toxic material for the protection of contractor and Air Force personnel shall be accomplished when necessary, especially during the drilling operation.

To accomplish this effort, contractor shall take the following steps:

A. General

1. Locations where surface water, sediment, and core samples are collected shall be marked with a permanent marker, and the location recorded on a site map.

2. A total of eight monitoring wells shall be installed in the immediately vicinity of the fuel spill. The exact location of the wells shall be determined in the field.

3. Ground-water monitoring wells in 2. shall be completed to a depth of at least 10 feet below the average water table surface, <u>and the well screen shall extend at least 5 feet above the water table</u>. All wells shall be developed, water levels measured, and locations surveyed and recorded on a site map.

4. Ground-water monitoring wells shall comply with U.S. EPA publication 330/9-81-002 <u>NEIC Manual for Groundwater/Subsurface Investigations at Hazardous Waste Sites</u>, and State of New Jersey requirements for monitoring well installation. All wells will be developed until they produce clear, sand-free water. Only screw type joints shall be used. Glue fittings are not permitted.

5. All water samples shall be analyzed on site by the contractor for pH, temperature, and specific conductance. Sampling, maximum holding time, and preservation of samples shall comply strictly with the following references: <u>Standard Methods for the Examination of Water and Wastewater</u>, 15th Ed. (1980), pp 35-42; <u>ASTM</u>, Part 31, pp 72-82, (1976), Method D-3370; and <u>Methods for Chemical Analysis of Water and Wastes</u>, EPA Manual

* Highlights of modification are underscored

600/4-79-020, pp xiii to xix (1979). All water samples shall be analyzed using minimum detection levels, as specified in Attachment 1.

6. The contractor shall split all water and soil samples. One set of samples shall be analyzed by the contractor and the other set of samples shall be delivered immediately (the same collection day) to the field government point of contact (POC). The field POC will select 10% of the split samples for subsequent shipment and analysis and deliver them to the contractor within 24 hours of receipt. The contractor shall supply all packing and shipping materials for the field POC's use in packaging the split samples. The contractor shall accept from the field POC packaged samples for immediate shipment (within 24 hours) for analysis through overnight delivery to:

USAF OEHL/SA
Bldg 140
Brooks AFB TX 78235-5501

The Samples sent to the USAF OEHL/SA shall be accompanied by the following information:

(a) Purpose of sample (analyte)

(b) Installation name (base)

(c) Sample number (on containers)

(d) Source/location of sample

(e) Contract Task Numbers and Title of Project

(f) Method of collection (bailer, suction pump, air-lift pump, etc.)

(g) Volumes removed before sample taken

(h) Special Conditions (use of surrogate standard, special nonstandard preservations, etc.)

(i) Preservatives used

(j) Date and time of sampling

(k) Sampler's name

This information shall be forwarded with each sample by properly completing an AF Form 2752 (copy of form and instructions on proper completi mailed under separate cover). In addition, copies of field logs documenting sample collection should accompany the samples. Chain-of custody records fo all samples, field blanks and quality control duplicates shall be maintainec All contractor QA/AC program analysis results shall be included in the analy ical results of draft final report (as specified in Item VI below).

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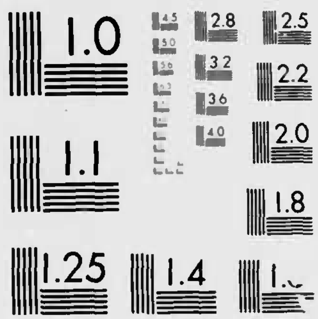


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

7. Field data collected from this investigation shall be plotted and mapped. The nature of contamination and the magnitude and potential for contaminant flow within this site receiving streams and ground waters shall be determined or estimated. Upon completion of the sampling and analysis, the data shall be tabulated in the next R&D Status Report, as specified in Item VI below.

B. In addition to items delineated in A above, conduct the following specific actions at the former railroad off-loading site identified on McGuire AFB NJ:

1. A total of 30 soil borings shall be drilled at this site in the immediate vicinity of the fuel spill and between the spill and South Run. Borings shall be advanced to 2 feet below the average water table surface. Samples shall be retained for analysis and composited at 1 foot intervals in the areas of soil staining and at every spoon interval (1.5 - 2.0 feet) where staining is not evident, and at the saturated/unsaturated zone interface. A maximum of 60 samples shall be analyzed.

2. Each soil sample shall be analyzed for oil and grease-infrared method (O&G/IR).

3. Collect 50 near-surface soil samples with a hand auger in the 0 - 2 foot horizon in the immediate vicinity of the fuel spill. A maximum of 15 samples shall be analyzed.

4. Each near-surface soil sample shall be analyzed for O&G/IR.

5. Install eight ground-water monitoring wells, two wells placed upgradient of the site and six wells placed downgradient of the site. Wells shall be an average of 25 feet in depth; total footage drilled shall not exceed 200 feet.

6. Collect two water samples from each well. Prior to purging and sampling, petroleum product thicknesses, if present, will be measured at each well.

7. Each ground-water sample shall be analyzed for O&G/IR, benzene, toluene and xylene.

8. The South Run Creek bank shall be inspected for the presence of oil seepage. If present, two seepages shall be collected and analyzed for O&G/IR, benzene, toluene and xylene.

9. Collect one water sample from existing wells 12 and 13.

10. Each sample shall be analyzed for O&G/IR, benzene, toluene, and xylene.

C. Well Installation and Clean-up

The well and boring area shall be cleaned following the completion

of each well and boring. Drill cuttings shall be removed and the general area clean. If hazardous waste is generated in the process of well installation, the contractor shall be responsible for proper containerization for eventual government disposal. Disposal of drill cuttings is not the reponsibility of the contractor.

D. Results of all sampling and analysis shall be tabulated and incorporated in the Informal Technical Information Report (Sequence 3 Atch 1 and Sequence 2 Atch 3 as specified in Item VI below) and forwarded to USAF OEHL/TS for review.

E. Reporting

1. A draft report delineating all findings of this field investigation shall be prepared and forwarded to the USAF OEHL, as specified in Item VI below, for Air Force review and comment. This report shall include site maps showing the distribution of contaminated soils and estimates of the depths of contamination, distributions of floating fuel product on groundwater surface and estimates of the volume present, analysis of subsurface conditions and groundwater flow related to possible interception and recovery alternatives, well logs of all project wells, data from water level surveys, water quality analysis results, available geohydorlogic cross sections, ground-water surface and gradient vector maps, any available vertical and horizontal flow vectors, and laboratory quality assurance information. The report shall follow the USAF OEHL format (mailed under separate cover).

2. Determinations shall be made of the magnitude and direction of movement of contaminants discovered. Potential environmental consequences of contamination shall be identified or estimated. Where survey data are insufficient to properly determine or estimate the magnitude and direction of movement of contaminants, fully justified specific recommendations shall be made for additional efforts required to properly evaluate contaminant migration.

3. Specific requirements, if any, for additional soil borings or for future ground-water monitoring must be identified.

F. Using information from the hydorgeological investigation, identify and evaluate 2 or 3 viable alternatives for restoration of the aquifer and soils. Each alternative program shall be conceptually developed to describe how component technologies will be applied, estimated performances, construction requirements, major equipment sizes, design parameters, and concept level capital and operating cost estimates. Each alternative shall be evaluated on the basis of technical feasibility, cost-effectiveness, implementation time frame and enviornmental effectiveness, and capability fo- implementation and operation using Base manpower resources.

G. Meetings

The contractor and project leader shall meet with Air Force

officials and/or state or federal environmental regulatory agency representatives on two separate occasions for eight hours each to present and discuss results of this investigation at McGuire AFB. Meetings will be called by USAF OEHL.

H. Cost Estimates

The contractor shall provide cost estimates for all additional work recommended to permit proper determination of contaminants. The recommendations provided shall include viable alternative technologies for restoration of the aquifer and soils along with an estimate of the time required to accomplish the proposed effort. This information shall be provided in a separately bound appendix to the draft final report.

II. Site Location and Dates:

McGuire AFB NJ
Time and Dates
To be established

III. Base Support: None

IV. Government Furnished Property: None

V. Government Points of Contact:

1. Lt Maria R. LaMagna
USAF OEHL/TS
Brooks AFB TX 78235-5501
(512) 536-2158
AV 240-2158

2. Maj John Ellis
USAF Clinic/SGPB
McGuire AFB NJ 08641-5300
(609) 724-4174
AV 440-4174

3. LtCol Edwin C. Banner III
HQ MAC/SGPB
Scott AFB IL 62225-5000
(618) 256-2306
AV 638-2306

VI. In addition to sequence numbers 1, 5 and 11 which are applicable to all orders, the reference numbers below are applicable to this order. Also shown are data applicable to this order:

Sequence No.	Block 10	Block 11	Block 12	Block 13	Block 14
Atch 1					
4	ONE/R	85SEP30	85OCT30	86MAR31	*
3	ONE/T	**	**		2
Atch 3					
2	ONE/T	**	**		2

*Two draft reports will be required. After incorporating Air Force comments concerning the first draft report, the contractor shall supply the USAF OEHL with a second draft report. The report will be forwarded to the applicable regulatory agencies for their comments. The contractor shall supply the USAF OEHL with 20 copies of each draft report and 50 copies plus the original camera ready copy of the final report.

**Upon completion of analysis

Attachment I

Levels of Detection Required

levels of Detection are for water unless shown otherwise:

Analyte	Analytical Method	Detection Limit	No. Sample Total,	QC
Oil and grease (IR Method)....	EPA Method 413.2*	100 ug/L (waters)	28	4
		100 ug/g (soil)	90	15
pH..............................	EPA Method 150.1*		-	
Specific Conductance...........	EPA Method 120.1*	1 umho/cm	-	
Benzene........................	EPA Method 602	0.2 ug/L	24	4
Toluene........................	EPA Method 602	0.2 ug/L	24	4
Xylene.........................	EPA Method 602	0.4 ug/L	24	4

Reference: *Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, Mar 1979, USEPA

APPENDIX C

PROFESSIONAL PROFILES OF PROJECT PERSONNEL

1670B

Peter J. Marks

Fields of Competence

Project management; environmental analytical laboratory analysis; hazardous waste, groundwater and soil contamination; source emissions/ambient air sampling; wastewater treatment; biological monitoring methods; and environmental engineering.

Experience Summary

Eighteen years in Environmental Laboratory and Environmental Engineering as Project Scientist, Project Engineer, Process Development Supervisor, and Manager of Environmental Laboratory with WESTON. Experience in analytical laboratory, wastewater surveys, hazardous waste, groundwater and soil contamination, DoD-specific wastes, stream surveys, process development studies, and source emission and ambient air testing. In-depth experience in pulp and paper, steel, organic chemicals, pharmaceutical, glass, petroleum, petrochemical, metal plating, food industries and DoD.

Applied research on a number of advanced wastewater treatment projects funded by Federal EPA.

Credentials

B.S., Biology—Franklin and Marshall College (1963)

M.S., Environmental Engineering and Science—Drexel University (1965)

American Society for Testing and Materials

Water Pollution Control Federation

Water Pollution Control Association of Pennsylvania

Employment History

1965-Present	WESTON
1963-1964	Lancaster County General Hospital Research Laboratory for Analytical Methods Development

Key Projects

USAF/OEHL Brooks AFB. Program Manager for this three-year BOA contract provides technical support in environmental engineering surveys, wastewater characterization programs, geological investigations, hydrogeological studies, landfill leachate monitoring and landfill siting investigations, bioassay studies, wastewater and hazardous waste treatability studies, and laboratory testing and/or field investigations of environmental instrumentation/equipment. Collection, analysis, and reporting of contaminants present in water and wastewater samples in support of Air Force Environmental Health Programs.

United States Army Toxic and Hazardous Materials Agency (USATHAMA), Aberdeen Proving Ground, Maryland. Program Manager for three-year basic ordering agreement contract to provide research and development for technology in support of the DOD Installation Restoration Program. The objective of the Program is to identify and develop treatment methods/technology for containment and/or remedial action. Technology development for remedial action is to include groundwater, soils, sediments, and sludges.

Confidential Client, Ohio. Project Manager of an on-going contract to conduct corporate environmental testing and special projects at client's U.S. and overseas plants. WESTON must be able to assign up to four professionals to a project within a two week notice.

Confidential Client (Inorganic and Organic Chemicals). Product Manager of a current contract to conduct wastewater sampling and analysis of plant effluent for priority pollutants. The project also includes a wastewater treatability study to evaluate a number of process alternatives for removal of priority pollutants from the present effluent.

Confidential Client, Utah. Technical Project Manager for in-depth wastewater survey, in-plant study, treatability study, and concept engineering study in support of the client's objectives to meet 1983 effluent limitations. WESTON had two project engineers, two chemists, five technicians and an operating laboratory in the field. Field effort is six months duration.

Professional Profile

In conjunction with University of Delaware College, WESTON analyzed more than 500 biological and marine sediment samples for eleven constituent trace metals as part of a program to identify and trace the migration of metals from ocean dumping of sludges on the continental shelf off the coast of the State of Delaware, acted as Technical Project Manager.

Project Manager in charge of a wastewater analysis and biological treatability project for industrial client for the identification and degradation of six pesticide-containing wastewaters.

U.S. EPA Environmental Monitoring and Support Laboratory. Multi-year contract to provide reference laboratory analysis on QA/QC samples produced from the EPA Analytical Laboratory QA/QC program.

Publications

"Microbiological Inhibition Testing Procedure," Biological Methods for the Assessment of Water Quality, A.S.T.M. Publication STP 528.

"Heat Treatment of Waste Activated Sludge" (with V.T. Stack).

"Biological Monitoring In Activated Sludge Treatment Process," a joint paper with Stover/Woldman.

Frederick Bopp III, Ph.D., P.G.

Registration

Registered Professional Geologist in the State of Indiana

Fields of Competence

Groundwater resources evaluation; hydrogeologic evaluation of sanitary landfills and other waste disposal sites; detection and abatement of groundwater pollution; digital modeling of groundwater flow and solute transport; statistical analysis of geological and geochemical data; geochemical prospecting; estuarine geology and geochemistry; trace metal and aqueous geochemistry.

Experience Summary

Seven• years experience in hydrogeology and geochemistry, involving such activities as: assessment of subsurface water and soil contamination; development of contamination profiles; evaluation of remediation actions for groundwater quality restoration; quantitative chemical analysis of water and soil; ore assay and ore body evaluation; drilling supervisor; hydrogeologic assessment; pollution detection and abatement; estuarine pollution analysis; application of flow and solute transport computer models; computer programming; project management; teaching environmental geology and geochemistry.

Credentials

B.A., Geology—Brown University (1966)

M.S., Geology—University of Delaware (1973)

Ph.D., Geology—University of Delaware (1979)

Sigma Xi, The Scientific Research Society of North America

Geological Society of America, Hydrology Division

National Water Well Association, Technical Division

American Association for the Advancement of Science

Estuarine Research Federation: Atlantic Estuarine Research Society

Employment History

1979-Present	WESTON
1977-1979	U.S. Army Corps of Engineers Waterways Experiment Station
1976-1977	University of South Florida Department of Geology
1970-1976	University of Delaware Department of Geology
1974-1976	Earth Quest Associates President and Principal Partner
1974 (Summer)	WESTON
1966-1970	United States Navy Commissioned Officer

Key Projects

Project manager on seven task orders for environmental assessment services at United States Air Force facilities in nine states.

Task manager for a Superfund site evaluation in Ohio.

Site manager for drum recovery operations in Pennsylvania and New Jersey.

Project manager for site assessments of oil and fuel spills in four states.

Project manager for closure plan development at a hazardous waste landfill in New Jersey.

Definition and abatement of groundwater contamination from chemical manufacturing in Delaware.

Flow and solute transport digital model of a heavily-pumped regional aquifer in southern New Jersey.

Definition and abatement of groundwater contamination from chemical manufacturing in the Denver area.

Hydrogeologic impact assessment of on-land dredge spoil disposal in coastal North Carolina.

Geochemical prospecting and ore body analysis in Arizona.

Professional Profile

Definition and abatement of groundwater contamination from a hazardous waste site in northern New England.

Definition and abatement of groundwater contamination from plating and foundry wastes in eastern Pennsylvania.

Operational test and evaluation of new naval mine ordinances in southern Florida.

Publications

"Metals in Estuarine Sediments: Factor Analysis and Its Environmental Significance". *Science*, 214 (1981): 441-443.

"The Remobilization of Trace Metals from Suspended Sediments Entering the Delaware Estuary". Presented at the 27th Annual Meeting, Southeastern Section, Geological Society of America, Chattanooga, Tennessee, April 1978.

"Trace Metals in Delaware Bay Sediments and Oysters". Presented at the International Conference on Heavy Metals in the Environment, Toronto, Canada, October 1975.

Walter M. Leis, P.G.

Registration

Registered Professional Geologist in the States of Georgia (No. 440) and Indiana.

Fields of Competence

Detection and abatement of groundwater contamination; design of artificial recharge wells; deep well disposal; simulation of groundwater systems; hydrogeologic evaluation of hazardous waste sites and landfills; practical applications of geophysical surveys to hydrologic systems, site investigations, and borehole geophysical surveys. Geochemical studies of acid mine drainage and hazardous wastes.

Experience Summary

Sixteen years experience as field hydrogeologist, field supervisor, project director, research director. Six years research involving two consecutive projects: 1) application of geophysical techniques in evaluating groundwater supplies in fractured rock terrain in Delaware and Pennsylvania; 2) project director for an artificial recharge and deep well disposal study. Provided consultation for waste disposal and aquifer quality problems for coastal communities.

Developed geochemical sampling techniques for deep mine sampling. Evaluated synthetic and field hydrologic data for deep formulational analysis in coal field projects.

Earlier research experience involved developing techniques for mapping subsurface regional structures having interstate hydrologic significance, and defining ore bodies by geochemical prospecting.

Credentials

B.S., Biochemistry—Albright College (1966)

M.S., Hydrogeology—University of Delaware (1975)

Cooperative Program Environmental Engineering—University of Pennsylvania

Additional special course work in Geology and Hydrology, Franklin and Marshall College and Pennsylvania State University

Remote Sensing Data Processing Training, Goddard Space Center (1978)

OWRR Research Fellow, 1973

National Water Well Association, Technical Division.

Geological Society of America, Engineering Geological Division.

Society of Economic Paleontologists and Mineralogists

Employment History

1974-Present	WESTON
1973-1974	University of Delaware Water Resources Center
1971-1973	University of Delaware
1967-1971	Pennsylvania Department of Environmental Resources

Key Projects

Definition of groundwater contamination from sanitary landfill leachate and recovery of contaminants to protect heavily used aquifer in Delaware.

Field design studies for artificial recharge and waste disposal wells.

Design and construction of hydrologic isolation systems for various class hazardous wastes.

Design and supervision of chemical and physical rehabilitation of groundwater collection systems in fractured rock and coastal plain areas.

Principal investigator for six projects involving subsurface migration of PCB's in New York, New Jersey, Pennsylvania, and Oklahoma.

Design and construction supervision of hydrocarbon recovery wells in Pennsylvania.

Professional Profile

Geochemical evaluation of coal mine pools in West Virginia.

Geochemistry of subsurface migration of toxic substances.

Principal investigator for eight projects involving migration of volatile chlorinated hydrocarbons in groundwater.

Mineable reserve evaluations for coal, sand and gravel, limestone, clay deposits, mine reclamation, and monitoring.

Design geophysical and remote sensing assessments of hazardous waste disposal areas.

Publications

Leis, W., and R.R. Jordan, 1974, "Geologic Control of Groundwater Movement in a Portion of the Delaware Piedmont", OWRR—DEL 20.

Leis, W., 1976, "Artificial Recharge for Coastal Sussex County, Delaware", University of Delaware Press, Water Resources Center.

Leis, W., D.R. Clark, and A. Thomas, 1976, "Control Program for Leachate Affecting a Multiple Aquifer System, Army Creek Landfill, New Castle County, Delaware", National Conference on Management and Disposal of Residue on Land.

Leis, W., W.F. Beers, J.M. Davidson, and G.D. Knowles, 1978, "Migration of PCB's by Groundwater Transport—A Case Study of Twelve Landfills & Dredge Disposal Sites on the Upper Hudson Valley, New York", Proceedings of the 1st Annual Conference of Applied Research & Practice on Municipal and Industrial Waste.

Leis, W., R.D. Moose, and W.F. Beers, "Critical Area Maps, a Regional Assessment for Karst Topography", Association of Engineering Geologists 1978 Annual Meeting.

Leis, W., and W.F. Beers, "Soil Isotherm Studies to Predict PCB Migration Within Groundwater", (Abstract) ASTM 1979 Annual Meeting, Philadelphia, Pennsylvania.

Thomas, A., and W. Lein, "Physical & Chemical Rehabilitation of Contaminant Recovery Wells", Association of Engineering Geologists 1978 Annual Meeting.

Leis, W., W.F. Beers, and F. Benenati, "Migration of PCB's from Landfills and Dredge Disposal Sites in the Upper Hudson River Valley", New York Academy of Science Symposium on PCB's in the Hudson River.

Leis, W., "Subsurface Reclamation by Counter Pumping Systems: Geologic and Geotechnical Aspects of Land Reclamation", ASCE/AEG 1979 Symposium.

Leis, W., and A. Metry, "Field Characterization of Leachate Quality", Water Pollution Control Federation 1979 Annual Meeting.

Leis, W., and A. Metry, "Multimedia Pathways of Contaminant Migration", Water Pollution Control Federation 1980 Annual Meeting.

Leis, W., and K. Sheedy, "Geophysical Location of Abandoned Waste Disposal Sites", 1980 National Conference on Management of Uncontrolled Hazardous Waste Sites.

Sheedy, K., and W. Leis, 1982, "Hydrogeological Assessment in Karst Environments (chapter)."

John A. Williams, Jr.

Fields of Competence

Geologic and geophysical investigations; geological and groundwater sampling techniques and instrumentation technology; design, operation, and evaluation of geophysical survey, equipment, testing and analysis of aquifers, and groundwater pollution.

Experience Summary

Three years experience in geologic and geophysical investigtions including subsurface profiling using Ground Penetrating Radar (GPR), electrical resistivity and electromagnetic conductivity for numerous private and government facilities; groundwater sampling and aquifer pump tests, six years experience in bathymetric, hydrographic and biological studies.

Credentials

A. S., Marine Technology - Cape Fear Technical Institute (1975)

B. S., Earth Science (Geology) - West Chester State College (1983)

Certified Ground Penetrating Radar Operator

Certified NAUI/PADDI Scuba Diver

Geological Society of America

Employment History

1982 - Present	WESTON
1980-1982	Environmental Resources Management, Inc.
1977-1980	WESTON
1976-1977	Highway Service Marineland
1975-1976	Lawler, Matusky, Skelly Engineers

Key Projects

Coordinated and supervised geophysical investigations to locate buried drums and to delineate the boundaries of a buried waste lagoon for a scrap recovery plant in Rhode Island.

Geophysical field investigation to locate buried trenches and waste lagoons for a government facility in California.

Geophysical field investigation, well installation and sample collection to determine the distribution of leachate, and the extent of contamination in a heavily-used aquifer in New York.

Geophysical investigation to define the lateral and vertical effect of fill deposition for a facility in Massachusetts.

Soils investigation to determine the extent of contamination from old waste lagoons and fire training areas for a government facility in Arizona.

Hydrogeologic investigation for a scrap recovery facility in western Pennsylvania.

Responsible for deploying benthic and water quality sampling gear and an electronic navigation system for a dredge spoils disposal study in Lake Erie.

Geophysical investigation (ground penetrating radar and electrical resistivity) to locate buried drums and delineate trench boundaries for a government facility in Ohio.

Professional Profile

Richard C. Johnson

Fields of Competence

Hydrologic and geologic investigations of waste disposal sites; engineering properties of soil and rock; laboratory determination of mechanical properties of soils; laboratory investigation of physical properties of sulfite sludges and coal burning wastes; hydrogeological analysis of limestone karst terrains; optical and x-ray diffraction analysis of geological materials.

Experience Summary

Three years experience in geotechnical and engineering geology, including hydrologic and geological investigation of landfill sites, industrial waste disposal assessment, evaluation of soil mass stability and bearing capacity at proposed sites of building and tank structures; development of remedial actions for sinkhole collapse around structures in limestone terrains; supervision of engineering of laboratory programs for soil and waste material testing.

Credentials

B.S.—LaSalle College (1969)

M.A. Geology—Temple University (1976)

Graduate course work in soil mechanics, engineering geology and hydrology—Drexel University (1979-1981)

Geological Society of America, Engineering Geology Division

U.S. National Group of Engineering Geology

Philadelphia Geologic Society

Employment History

1981-Present	WESTON
1979-1981	Valley Forge Laboratories Devon, Pennsylvania Engineering Geologist Supervisor, Soils and Materials Testing Laboratory
1978-1979	Ambric Engineering Philadelphia, Pennsylvania Field Geologist
1976-1977	American Cancer Society Philadelphia, Pennsylvania Director of Development and Education
1972-1975	Temple University Department of Geology Teaching and Research Assistant
1969-1971	City of Philadelphia Department of Licenses and Inspections Housing and Fire Inspector

Key Projects

Supervision of investigations in New Jersey and Pennsylvania to determine subsurface conditions at proposed waste disposal sites. Studies included developing geologic profiles of the sites, locating groundwater, and determining the engineering properties of undisturbed and remolded soils samples.

Project Manager and Principal Investigator for a subsurface investigation to determine soil conditions at the proposed site of 55,000 barrel fuel storage tanks in a flood plain area in northeast Pennsylvania. Supervised soil borings and performed analyses to predict settlement probabilities for flexible pad foundations.

Investigated geologic and hydrologic conditions in an expanding suburban area in southeastern Pennsylvania to determine past and future impacts of on-site sanitary systems.

Supervised exploratory drilling and developed foundation recommendations for proposed building construction projects in southeastern Pennsylvania.

Conducted site investigations in limestone sinkhole areas to develop recommendations for remedial action around threatened structures.

Developed and directed a testing program to evaluate preliminary rock anchor designs in a sewage facility construction project, Montgomery County, Pennsylvania.

Supervised laboratory testing program for sulfite sludges and coal burning wastes. Evaluated alternative methods of physical and chemical stabilization of the wastes, and developed applications for stabilized material in landfill, and earth stabilization problems.

Professional Profile

Publications

Johnson, R. and Myer, G., "Sillimanite Nodules in the Wissahickon Schist, Philadelphia," *Journal of the Pennsylvania Academy of Sciences*, vol. 49, 1975.

WESTON

APPENDIX D

SOIL BORING AND MONITOR WELL LOGS

1670B

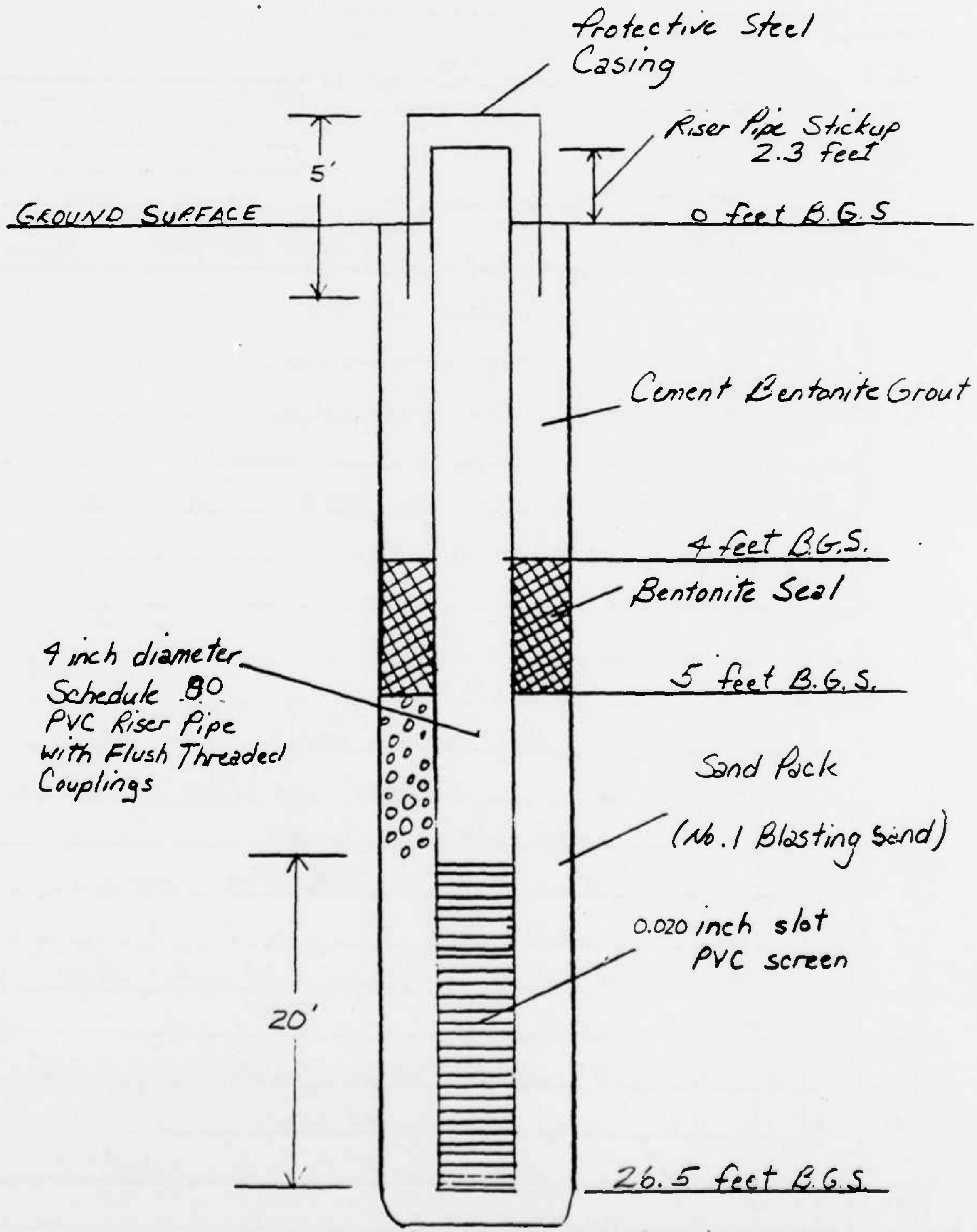
WESTON

BY ____________ DATE ________ DIV ____________ SHEET ____________ OF ______

CHKD BY ______ DATE ________ DEPT ____________ W.O. NO. ____________

PROJECT Mc Guire AFB

SUBJECT MW - 13



Well Construction Log McGuire AFB

WESTON

DRILLING LOG

WELL NUMBER: MW-1B
LOCATION: Bulk Fuel Storage Area
SURFACE ELEVATION:
DRILLING COMPANY: EMPIRE
DRILLER: Joe Jensen
LOG BY: J.A.W.

OWNER: USAF
ADDRESS: McGuire AFB
TOTAL DEPTH: 19.9'
WATER LEVEL:
DRILLING METHOD: Auger
DATE DRILLED: 3/11/85
HELPER:

SKETCH MAP

NOTES.

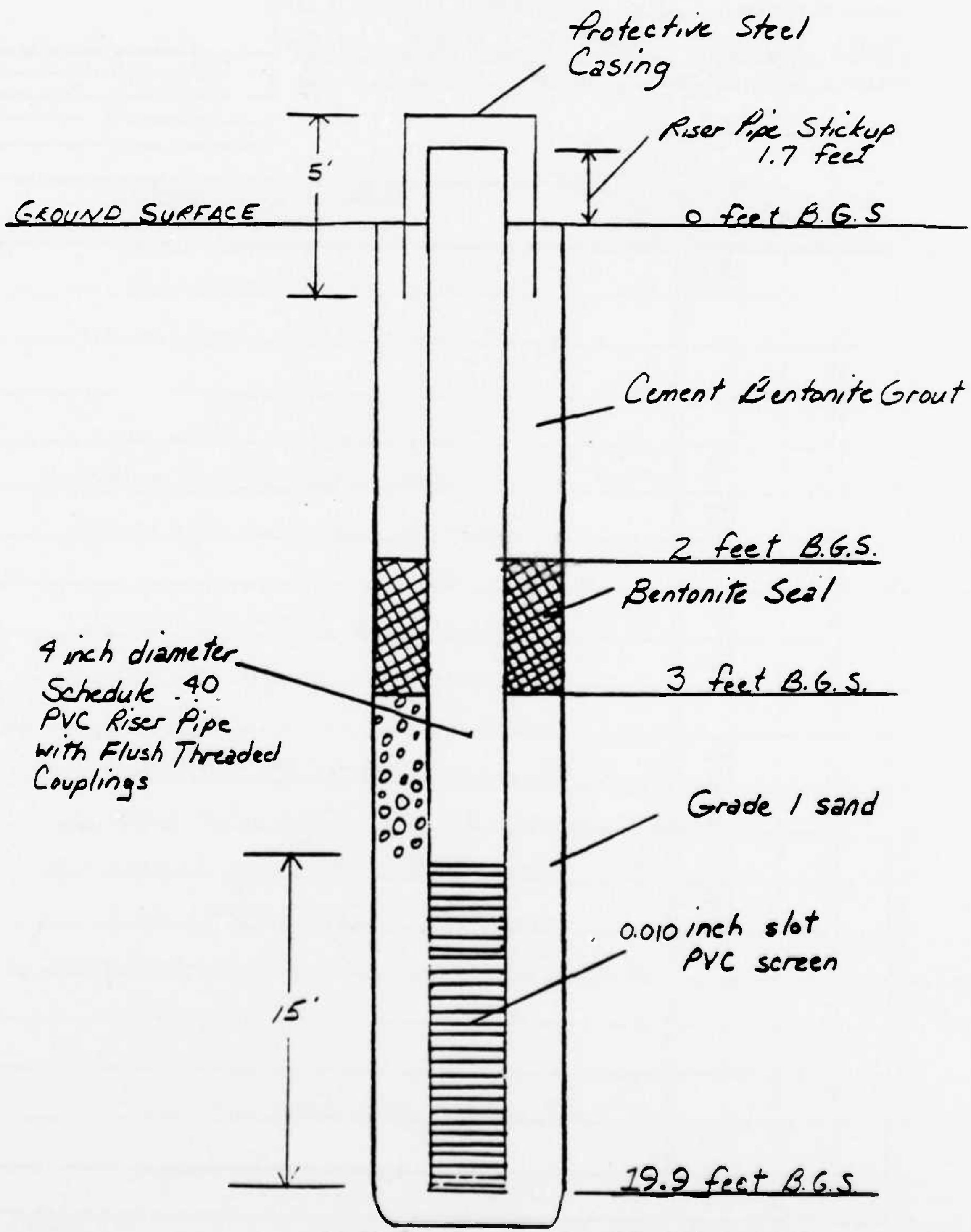
DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)	HNU (spoon)	HNU (j...
0					0'-.4' Topsoil	0.8	
				1/1	.4'-1' Brown SILT, sandy.		
				3/3	1'-1.5' SAND, fine, silty.		
				3 6			
5				10 13	5'-7' Olive brown SAND, fine to medium, some silt, damp.	110.0	6C
10				2/2	10'-11' Olive brown SAND, clayey, damp.	40.0	55
				4/4	11'-12' Olive brown CLAY, damp, cohesive with little fine sand.		
					12'-13' Olive brown SAND, fine, some silt, damp.		
15				7 5	13'-14' Black to brown (with depth) PEAT, damp.		
				5/15		180.0	25.
					17'-19' Black ORGANIC material, silty, loose, runny. Strong fuel odor.		
					19'-21' Brown black SILT, fine, sandy, dense, organics, wet.		

* A.S.T.M. D1586

SHEET ___ OF ___

WESTON

BY ______ DATE ______ DIV ______ SHEET ______ OF ______
CHKD BY ______ DATE ______ DEPT ______ W.O. NO. ______
PROJECT McGuire AFB
SUBJECT MW-18



Well Construction Log McGuire AFB

D-3

WESTON

DRILLING LOG

WELL NUMBER: MW-19 OWNER: USAF
LOCATION: Bulk Fuel Storage Area ADDRESS: McGuire AFB
TOTAL DEPTH 21.5'
SURFACE ELEVATION: WATER LEVEL:
DRILLING COMPANY: EMPIRE DRILLING METHOD: Auger DATE DRILLED: 3/11/85
DRILLER: Joe Jensen HELPER:
LOG BY: J.A.W.

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)	HNU
0				3 5 5 7	0'-2' Brown yellow SAND, medium with a .4' seam of black sand fine, silty	2.2
5				12 13 9 9	5'-7' Olive green SAND, medium, some silt. Grading to olive brown clay, sandy, some silt.	
				11 11 15 15	7'-9' Olive brown SILT, fine, sandy. Becoming moist to wet at bottom of spoon.	50.0
10				3 3 3 3	9'-11' Olive brown SAND silty. PEAT layer with product at 9.8'. Strong JP-4 odor.	75.0
				9 11 14	11'-13' Gray SAND, clayey. Grading to sandy clay, some silt. Slightly cohesive	35.0
15					15'-16' Gray SAND, medium, uniform, moist to wet	20.0
					18'-20' Dark gray SAND, silty, loose, wet.	

* A.S.T.M. D1586

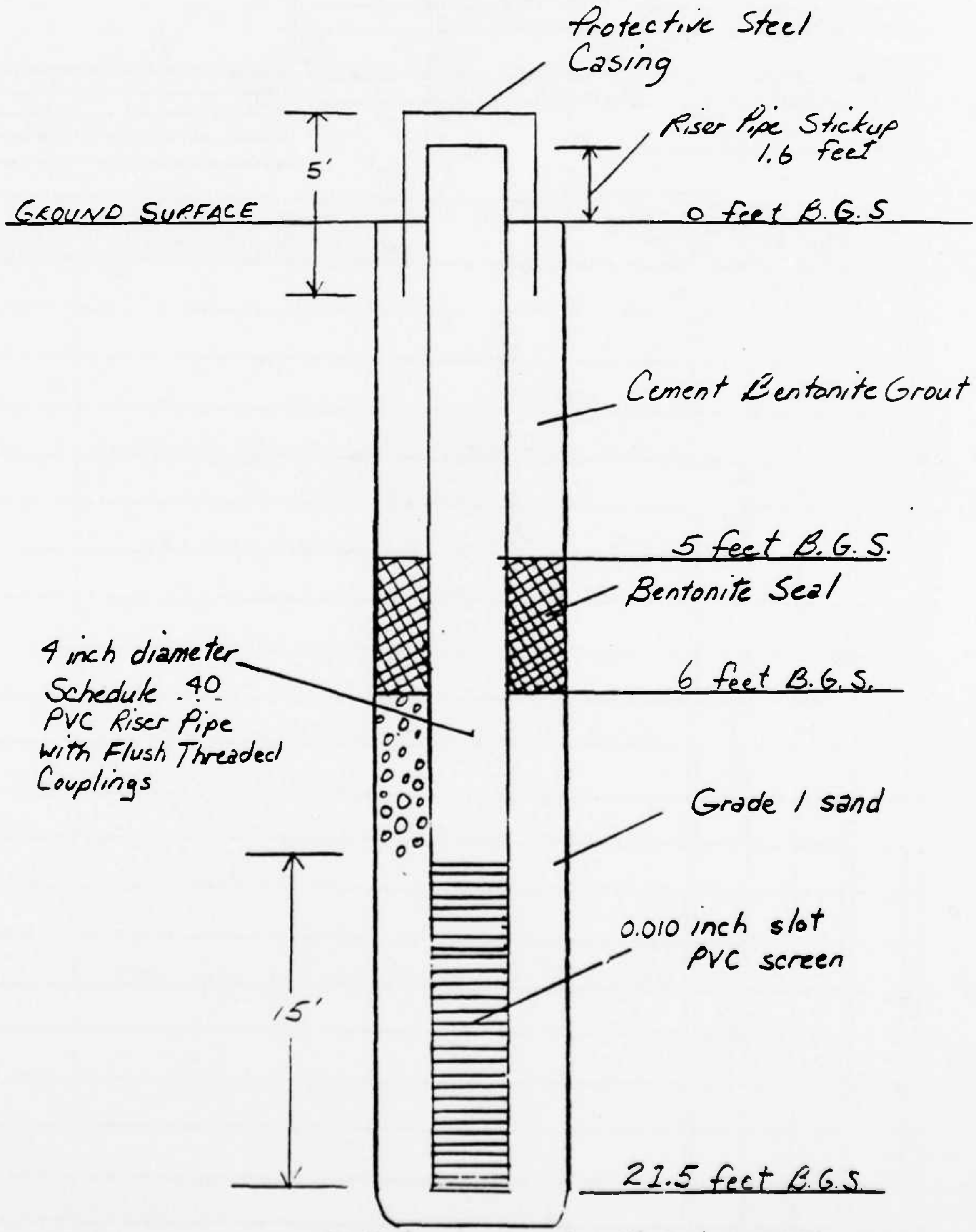
SHEET ___ OF ___

BY ______ DATE ______ DIV ______ SHEET ______ OF ______

CHKD BY ______ DATE ______ DEPT ______ W.O. NO. ______

PROJECT McGuire AFB

SUBJECT MW-19



Well Construction Log McGuire AFB

WESTON

DRILLING LOG

WELL NUMBER: MW-20
OWNER: USAF
LOCATION: Bulk Fuel Storage Area
ADDRESS: McGuire AFB
TOTAL DEPTH: 19'
SURFACE ELEVATION:
WATER LEVEL:
DRILLING COMPANY: Empire
DRILLING METHOD: Auger
DATE DRILLED: 3/12/85
DRILLER: Roger Logel
HELPER:
LOG BY: J.A.W.

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)	HNU (ppm)
0					0'-4' Topsoil	
						0.0
					4'-5' Dark brown Sand, gravelly, grading to fine to coarse sand	
5				8 / 11 / 13 / 14	5'-7' Orange to brown SAND, fine, little silt, dry, loose.	
10				4 / 5 / 5 / 4	10'-12' Tan SAND, fine, clean, wet	
						0.0
15				8 / 11 / 17 / 21	15'-17' Brown SAND, fine, silty, wet.	

* A.S.T.M. D1586

SHEET ___ OF ___

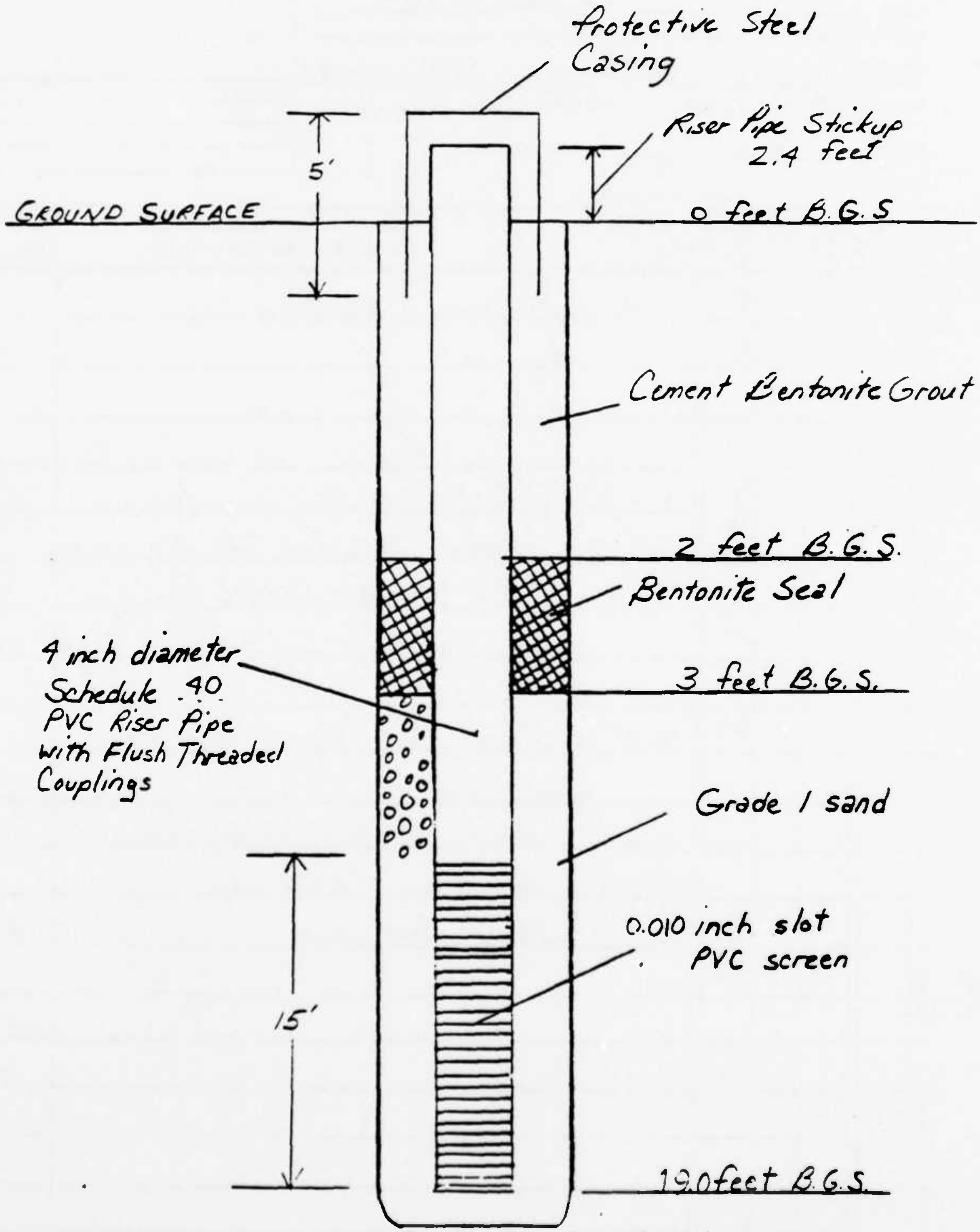
WESTON

BY ______ DATE ______ DIV ______ SHEET ______ OF ______

CHKD BY ______ DATE ______ DEPT ______ W.O. NO. ______

PROJECT Mc Guire AFB

SUBJECT MW-20



Well Construction Log McGuire AFB

WESTON

DRILLING LOG

WELL NUMBER: MW-21 OWNER: USAF
LOCATION: Bulk Fuel Storage Area ADDRESS: McGuire AFB
TOTAL DEPTH: 20.2'
SURFACE ELEVATION: WATER LEVEL:
DRILLING COMPANY: EmpirE DRILLING METHOD: Auger DATE DRILLED: 3/12/85
DRILLER: Roger Logel HELPER:
LOG BY: J.A.W.

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)	HNU (ppm)
0				2/4	0-2' Yellow brown to gray brown SAND,	
				6/9	clayey, wet.	0.0
				8/13	5'-5.5' Black COAL ASH, damp, loose.	0.0
5				23/50	5.5'-7 Mottled SAND, fine, little silt, damp.	
				11/32	7'-9' Black ASPHALT GRAVEL, fine to	
				100	coarse, mixed with fine to coarse SAND,	
				1/3	dry.	
				2/3	9'-11' Black CLAY, organic, some fine	
10					sand, damp.	50.0
					11'-12' Black SLUDGE, clayey, sandy.	
					12'-13' Red brown SAND, silty.	
				10/3	14' Slight fuel odor.	50.0
				3/6		
15						

* ASTM D1586

SHEET ___ OF ___

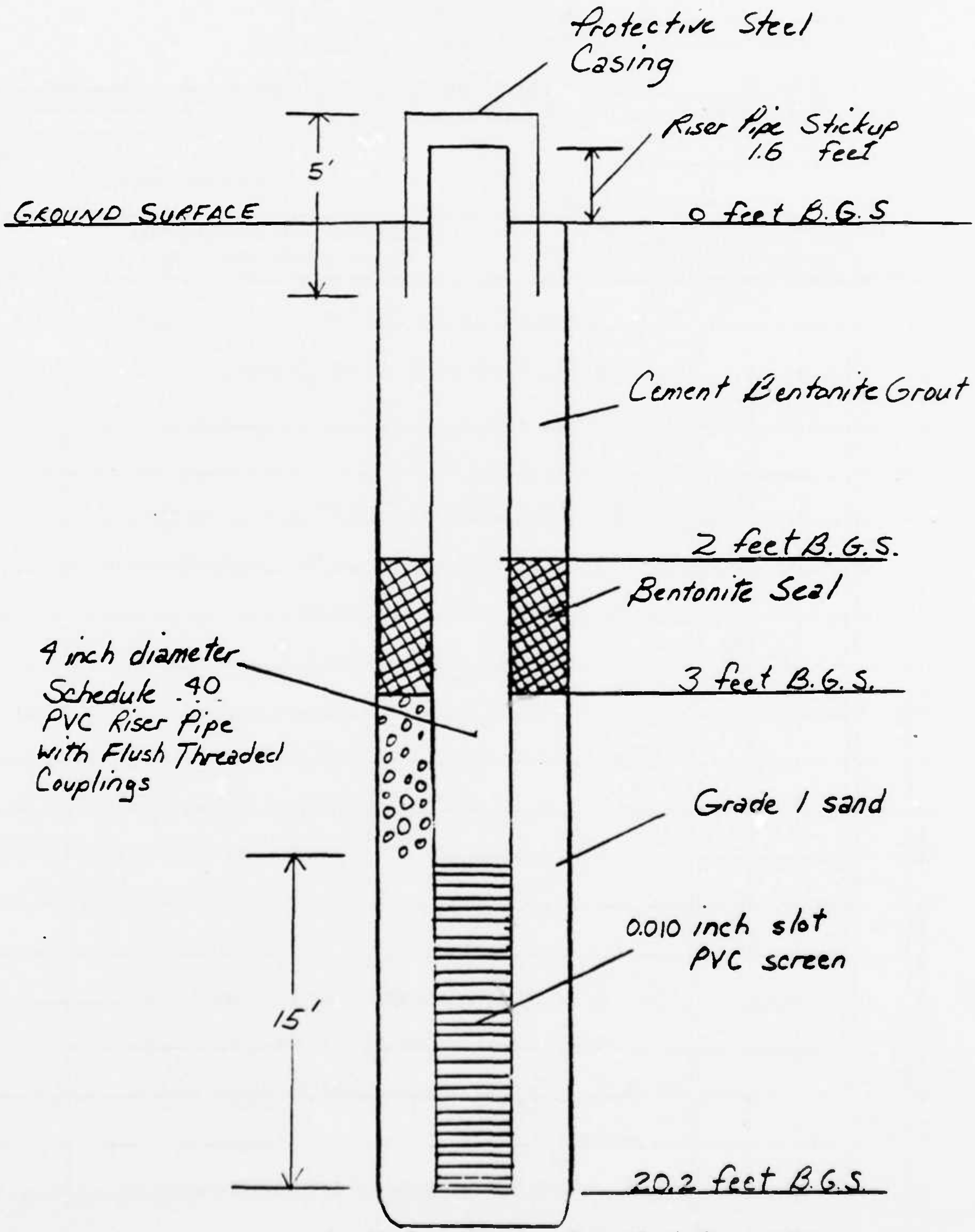
WESTON

BY ____ DATE ____ DIV ____ SHEET ____ OF ____

CHKD BY ____ DATE ____ DEPT ____ W.O. NO. ____

PROJECT McGuire AFB

SUBJECT MW - 21



Well Construction Log McGuire AFB

WESTON

SKETCH MAP

DRILLING LOG

WELL NUMBER: Mw-22
OWNER: USAF
LOCATION: Bulk Fuel Storage Area
ADDRESS: McGuire AFB
TOTAL DEPTH: 18.9'
SURFACE ELEVATION:
WATER LEVEL:
DRILLING COMPANY: EMPIRE
DRILLING METHOD: Auger
DATE DRILLED: 3/12/85
DRILLER: Roger Logel
HELPER:
LOG BY: J.A.W.

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)	HNU
0				2/3 3/5	0'-2' Reddish brown SAND, silty. Grading to coarse sand with some gravel.	0.0
5				7/8 10/10	5'-7 Olive brown SILT, fine, sandy. Grading to grayish white sand, medium with trace of silt and gravel.	0.0
				6/6 9/7	7'-9' Whitish gray SAND, medium to coarse	
10						
						0.0
15					15'-16' Mottled green black CLAY, fine, sandy, damp, dense. Grading to:	
					16-16.5' Organic brown SAND, silty, fine. Grading to:	
					16.5'-20' Dark gray SILT, dense, with little sand.	

* A.S.T.M. D1586

SHEET ___ OF ___

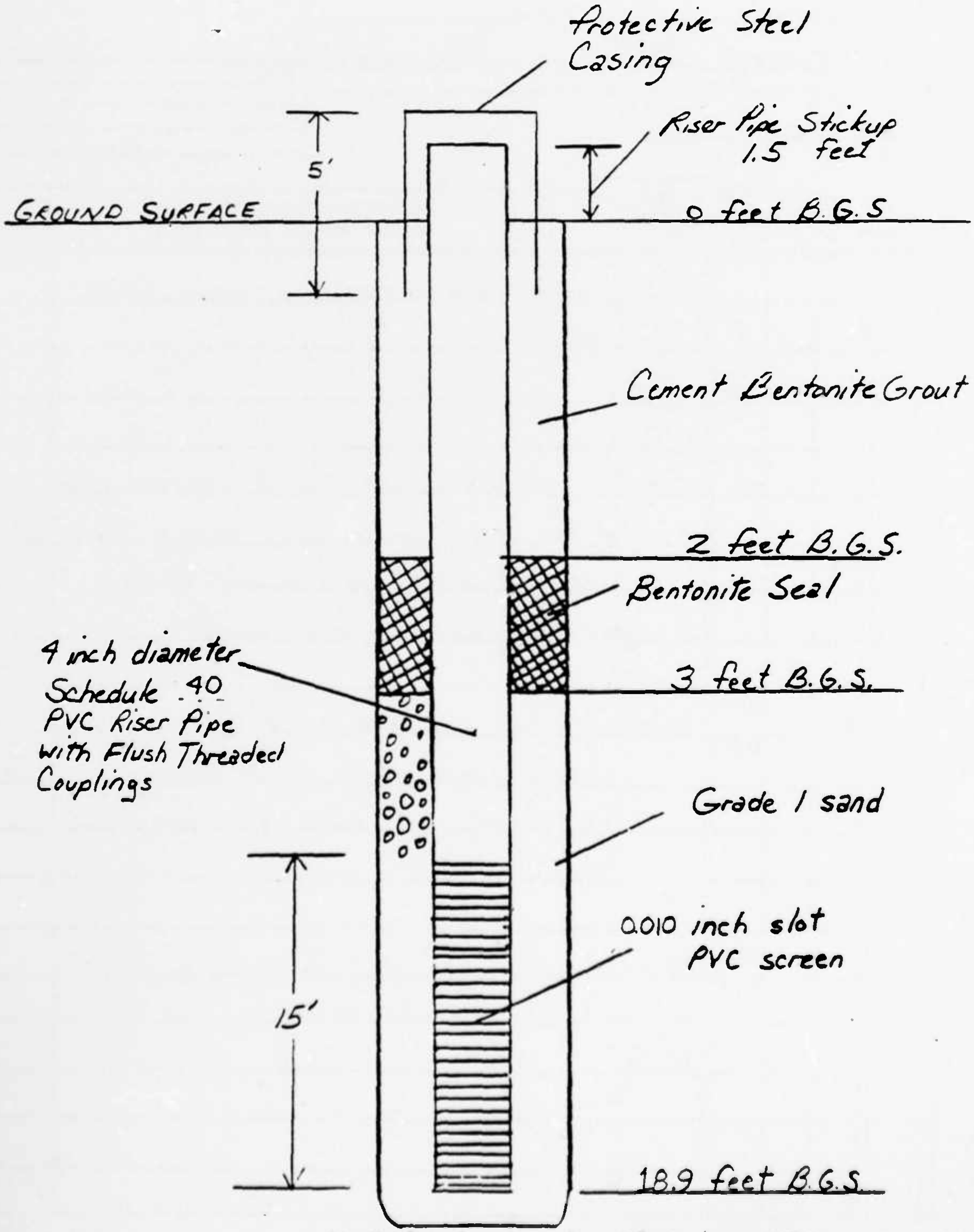
WESTON

BY ______ DATE ______ DIV ______ SHEET ______ OF ______

CHKD BY ______ DATE ______ DEPT ______ W.O. NO. ______

PROJECT McGUIRE AFB

SUBJECT MW-22



Well Construction Log McGuire AFB

WESTON

DRILLING LOG

WELL NUMBER: MW-23
OWNER: USAF
LOCATION: Bulk Fuel Storage Area
ADDRESS: McGuire AFB
TOTAL DEPTH: 19.3'
SURFACE ELEVATION:
WATER LEVEL:
DRILLING COMPANY: EMPIRE
DRILLING METHOD: Auger
DATE DRILLED: 3/13/85
DRILLER: Roger Lopel
HELPER:
LOG BY: JAW

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)	HNU
0					0-5' Yellow brown GRAVEL, fine-medium, loose, damp.	
5				4/7 7/8	5'-7' Brown SAND, fine to coarse, trace of fine gravel, loose, damp. Grading to fine sandy silt, slightly more compact, damp, mottling organic brown to gray.	0.0
10				9/11 14/17	10'-12' .25' Brown to black CLAY, organic, wet, with trace of fine sand. Grading to SILT, sandy, gray black, trace fine micas, damp.	0.0
15				11/12 13/13	15'-16' Brown CLAY, moist, crumbly, organic 16'-16.3' SAND, fine to coarse, some silt 16.8' Wet	0.0

* A.S.T.M. D1586

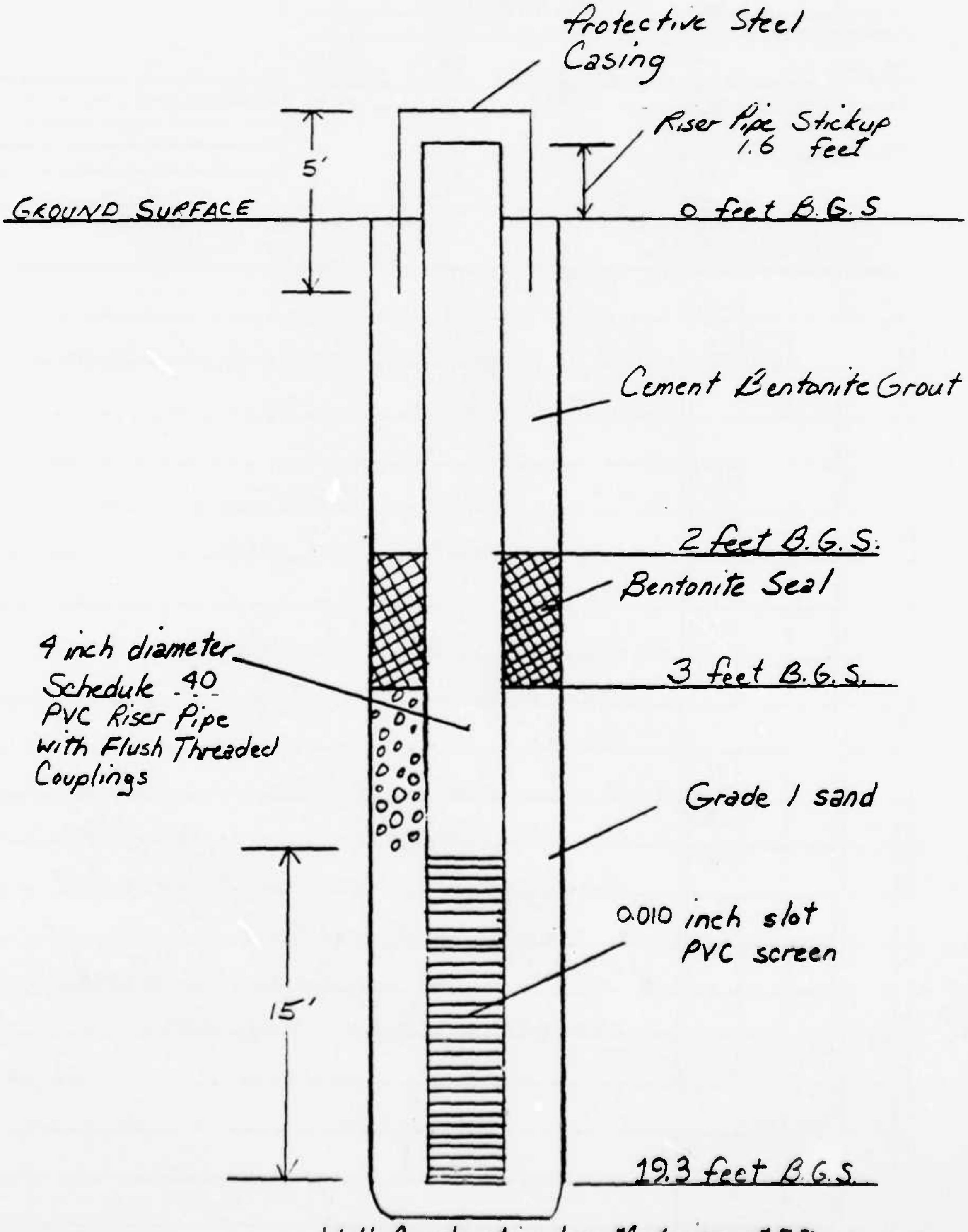
SHEET ___ OF ___

WESTON

BY	DATE	DIV	SHEET ___ OF ___
CHKD BY	DATE	DEPT	W.O. NO.

PROJECT McGUIRE AFB

SUBJECT MW-23



Well Construction Log McGuire AFB

WESTON

DRILLING LOG

WELL NUMBER: MW-24 OWNER: USAF

LOCATION: Bulk Fuel Storage Area ADDRESS: McGuire AFB

TOTAL DEPTH: 23'

SURFACE ELEVATION: WATER LEVEL:

DRILLING COMPANY: Empire DRILLING METHOD: Auger DATE DRILLED: 3/13/85

DRILLER: Roger Logel HELPER:

LOG BY: JAW

SKETCH MAP

NOTES

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)	
0					0'-.5' Topsoil	
				2/3		HNU
				2/6	.5'-2' Yellow brown SAND, silty, fine to coarse, loose, damp.	0.3
5				4/6 6/11	5'-7' Tan gray SAND, fine to coarse, clean, laminated; loose, damp.	1.2
				10/12 12/14	7'-9' SAND, fine to coarse, clean, trace of gravel, loose, damp dark gray banding	2.0
10				6/11 13/13	9'-11' Tan SAND fine to coarse, clean, loose, wet.	2.0
				15/20 22/2?	11'-13' Clean SAND, fine to coarse, loose, damp. Grading to gray sand, fine to coarse and Dark gray stained gravel, fine to coarse, wet.	60.0
15					15'-20' Dark gray SAND, fine to coarse with little fine gravel. Fuel laden.	130.0 (in sample container)

* A.S.T.M. D1586

SHEET ___ OF ___

WESTON

DRILLING LOG

WELL NUMBER: MW-24
OWNER: USAF
LOCATION: Bulk Fuel Storage Area
ADDRESS: McGuire AFB
TOTAL DEPTH: 23'
SURFACE ELEVATION:
WATER LEVEL:
DRILLING COMPANY: EMPIRE
DRILLING METHOD: Auger
DATE DRILLED: 3/11/85
DRILLER: Joe Jensen
HELPER:
LOG BY: J.A.W.

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20					
					23'-24.8' Black SILT, dense, damp, with some fine sand and fine micas. Grading to silty sand, fine.
25					24.8'-25' Distinct change to SAND, fine to coarse, with some silt.

* A.S.T.M. D1586

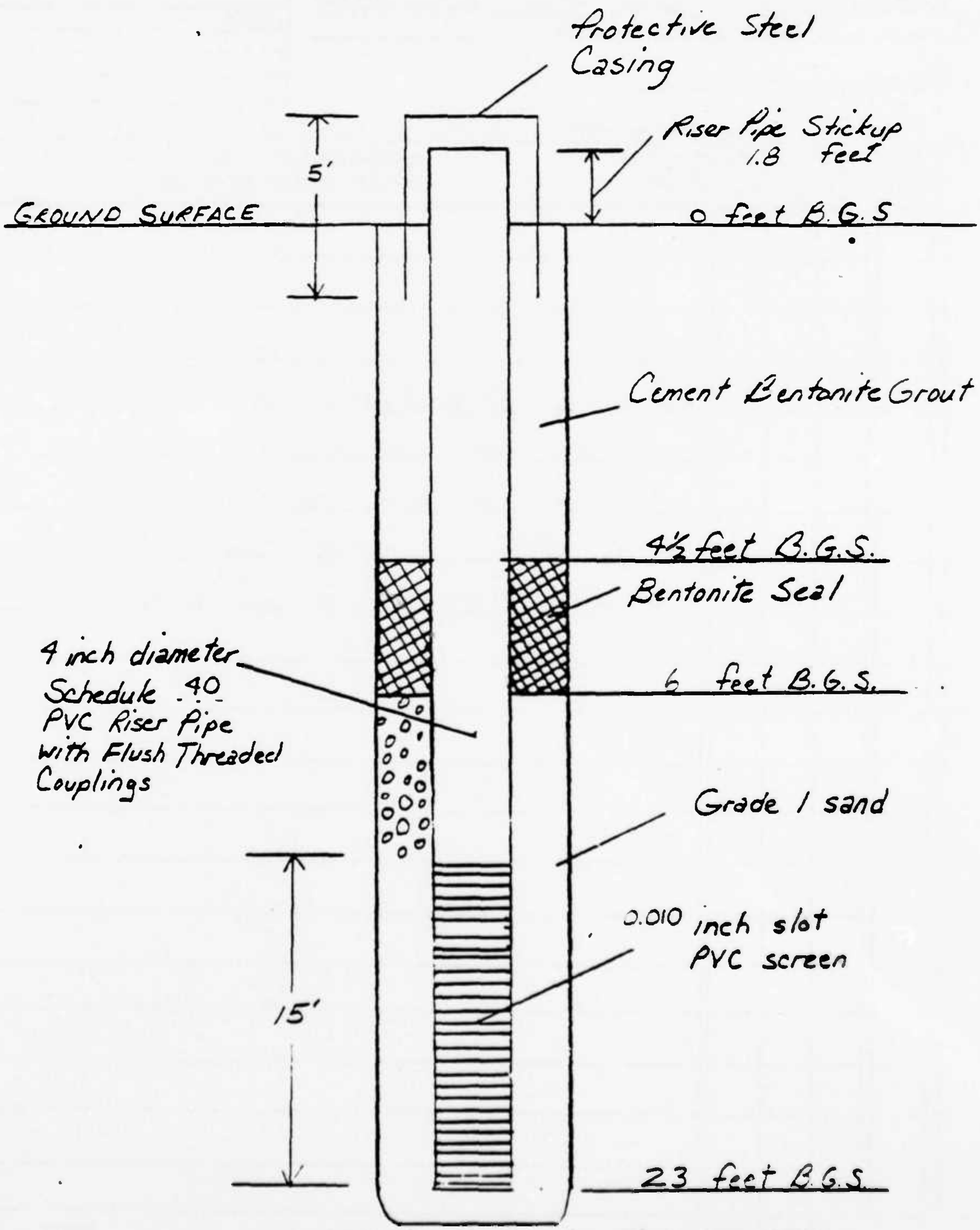
SHEET ___ OF ___

BY ______ DATE ______ DIV ______ SHEET ______ OF ______

CHKD BY ______ DATE ______ DEPT ______ W.O. NO. ______

PROJECT MC GUIRE AFB

SUBJECT MW-24



Well Construction Log McGuire AFB

Well Number mw-24 D-16

WESTON

DRILLING LOG

WELL NUMBER: MW-25 OWNER: USAF
LOCATION: Bulk Fuel Storage Area ADDRESS: McGuire AFB
TOTAL DEPTH: 19.5'
SURFACE ELEVATION: WATER LEVEL:
DRILLING COMPANY: EMPIRE DRILLING METHOD: Auger DATE DRILLED: 3/13/85
DRILLER: Roger Logel HELPER:
LOG BY: J. A. W.

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)	HNU
				2/3 4/4	0'-2' Green gray SAND, fine, little silt, loose.	0.0
5				14/15 16/17	5'-7' Gray green SAND, fine to medium, damp.	0.0
				13/19 20/35	7'-9' Black SAND, fine to medium	
10				3/3 3/4	9'-11' Black SAND, fine to medium, grades to green black SAND, fine, some clay, damp.	0.0
				5/7 7/7	11'-13' Green black SAND, medium, little clay, moist.	0.0
15						

* A.S.T.M. D1586

SHEET ___ OF ___

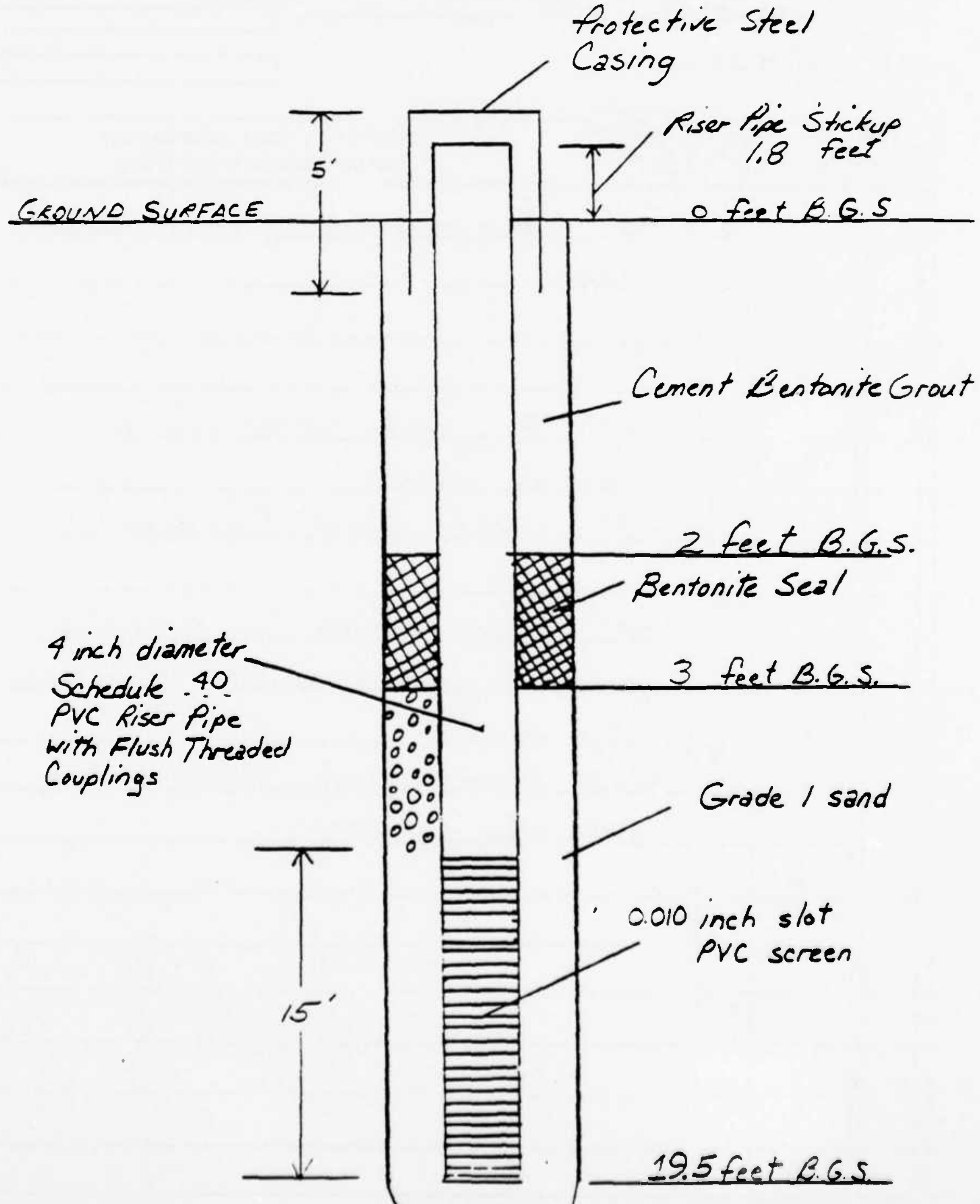
WESTON

BY ______ DATE ______ DIV ______ SHEET ______ OF ______

CHKD BY ______ DATE ______ DEPT ______ W.O. NO. ______

PROJECT McGUIRE AFB

SUBJECT MW-25



Well Construction Log McGuire AFB

ORING LOG

Page____ of____

Boring No. SP 1 Drill Company EMPIRE Log By Williams

Client USAF McGuire Driller Ebe Field Book No.

Job No. 0628-09 Date Began 5 March '85 End 5 March '85 Log Date 5 March '85

Drill Method 6" Hollow Stem Auger Rig CME-75

Sampling Method 24" Split Spoon No. Samples____ Total Depth 15'

Lithology	Depth	Sample No.	Interval	Recovery	Blow Count		Description	Remarks (HNU split spoon)	HNU (soil samples)
		#1ES		13"	6/9 8/6		.25-.75' Black COAL SLAG, fine to coarse. 1-2' Yellow brown SAND, fine to medium, damp.	{Background HNU ~0.3 HNU ~0.3	
	5	#2ES #1RFW		13"	2/2 3/4		5-6' Yellow brown CLAY, sandy, wet, plastic. 6-6.75' Black WOOD. 6.75-7' SAND, fine to medium.	HNU >30 strong odor of petrol.	60.0
	10	#3ES #2RFW		20"	8/16 11/9		10-12' Gray SAND, fine to medium, clean, damp, little GRAVEL, fine to medium, rounded.	~25± slight petrol. odor	75.0
	15	#4ES #3RFW		22"	2/3 3/5		15-17' Brown black SILT, sandy, wet, stiff.	~3.4	25.0

BORING LOG

Page____ of____

Boring No. SB 2 Drill Company EMPIRE Log By Williams

Client USAF McGuire Driller Joe Field Book No.

Job No. 0629-D9 Date Began 5 March 85 End Log Date

Drill Method 3" Hollow Stem Auger Rig CME 75

Sampling Method 24" Split Spoon No. Samples Total Depth 15

Lithology	Depth	Sample No.	Interval	Recovery	Blow Counts		Description	Remarks: HNU scan split spoon	HNU scan samples
		1ES		20"	3/5 4/6		0-2' Black COAL SLAG, fine to coarse.	BACKGROUND ~0.3	0.3
	5	2ES 1RFT		24"	4/10 10/10		5-6.5' Yellow brown SAND, silty, fine, damp. 6.5-7 White gray SAND, fine, clean	12.0	70.0
	10	3ES 2RFT		18"	4/4 2/5		10-12' Gray SAND, fine to medium, clean, wet, loose. Slight fuel odor	>15.0	100.0
	15	4ES 3RFT			7/5 7/5		15-17' Brown black SILT, sandy, micaceous, wet, stiff.	~3.0	50.0

BORING LOG

Page ____ of ____

Boring No. SB 3 Drill Company EMPIRE Log By Williams

Client ______ Driller ______ Field Book No. ______

Job No. ______ Date Began 5 March 85 End 5 March 85 Log Date ______

Drill Method HSA Rig ______

Sampling Method S/S No. Samples ______ Total Depth 15

Lithology	Depth	Sample No.	Interval	Recovery	Blow Cts.	Description	Remarks HNU Scan	HNU Scan
						0-.5' Topsoil	Background	0.3
						.5-1' Black COAL ASH.	0.3	
	2	1ES		24"	5/6 10/15	1-1.5' Orange brown SAND, fine to coarse, some silt.		
						1.5-2' Yellow brown SAND, fine to medium, clean, little coarse sand, damp, trace silt.		
	5	2ES 1RFN		24"	10/11 20/22	5-5.5' Yellow SAND, fine to coarse, trace fine gravel, saturated.	0.5	8.0
						5.5-7' Light brown SILT, fine, sandy, damp, stiff, some small twigs and sticks.		
	10	3ES 2RFN		24"	3/5 10/13	10-11.5' ROOTS, WOOD CHIPS, some fine sand, damp, black stain.	120.0	100.0
						11-12' Gray white SAND, fine, damp, clean.		
	15	4ES		24"	4/4 4/5	15-17' Brown black SILT, sandy, micaceous, wet, stiff.	1.2	6.0

BORING LOG

Page ___ of ___

Boring No. SP 4 Drill Company ___ Log By Williams

Client ___ Driller ___ Field Book No. ___

Job No. ___ Date Began 5 March 85 End 5 March 85 Log Date ___

Drill Method HSA Rig ___

Sampling Method S/S No. Samples ___ Total Depth 15

Lithology	Depth	Sample No.	Interval	Recovery	Blow Count		Description	HNU spoon	Remarks HNU sample scan
							0-.3' SAND, silty, some black ash.	Background 0.3	
		1ES RFW		22"	6/8 11/14		.3-2' Olive brown SAND, fine, little medium sand, trace silt.		
	5	2ES RFW		24"	10/12 10/12		5-7' Dark brown SILT, stiff, damp, trace sand, little organic matter.	4.5	7.0
	10	3ES RFW		22"	4/7 7/9		10-11' Brown SAND, silty, damp. 11-11.5' SAND, fine to medium and black coal ash, wet. 11.5-12' Gray SAND, fine to medium, clean, loose, saturated.	0.5	6.0
	15	4ES RFW		21"	4/4 5/4		15-15.5' Light brown SAND, fine, saturated, loose. 15.5-17' Black brown SILT, fine, wet, tight	0.3	8.0

BORING LOG

Page ___ of ___

Boring No. SB 5 Drill Company ___ Log By Williams

Client ___ Driller ___ Field Book No. ___

Job No. ___ Date Began 5 March 85 End 5 March 85 Log Date ___

Drill Method HSA Rig ___

Sampling Method S/S No. Samples ___ Total Depth 15'

Lithology	Depth	Sample No.	Interval	Recovery	Blow Counts		Description	Remarks HNU sample scan
			14"	6/5 8/10			0-3' SAND, silty, some black ash. .3-2' Olive brown SAND, fine, little medium sand, trace SILT.	105.0
	2	1ES RFW1						
		2ES RFW2						20.0
	5		20"	4/4 5/6			5-7' Dark brown SILT, stiff damp, trace sand, little organic matter,	
								4.5
	10	3ES RFW3	21"	1/2 2/2			10-11' Brown SAND, silty, damp. 11-11.5' SAND, fine to medium, clean, loose, saturated.	
								5.0
	15	4ES RFW4	20"	2/2 2/2			15-16' SAND, fine to coarse, with fine to medium gravel.	

BORING LOG

Page___ of___

Boring No. SP 6 Drill Company ___ Log By ___

Client ___ Driller ___ Field Book No. ___

Job No. ___ Date Began 5 March 85 End 5 March '85 Log Date ___

Drill Method HSA Rig ___

Sampling Method S/S No. Samples ___ Total Depth 15'

Lithology	Depth	Sample No.	Interval	Recovery			Description	HNU Spoon	Remarks	HNU Jar
		1ES RFN		18"	1/1 3/3		0-.3' Topsoil .3-1' Olive brown SAND, fine, silty. 1-1.3' Olive SAND, fine.	Background 0.3 0.8		
	5	2ES RFN		20"	3/6 10/13		5-7' Dark brown SILT, stiff, damp, trace SAND, little organic matter.	110.0		60.0
	10	3ES RFN		12"	2/2 4/4		10-10.5' Olive green SAND, fine to medium, loose.	40.0		35.0
	15	4ES RFN		18"	7/9 8/10		15-15.5' Black detrital material, wood (almost like creosote). Very strong fuel odor. 15.5-17 Olive brown SAND, fine to medium, saturated, loose.	180.0		25.0

ƆRING LOG

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Boring No. SP 7 Drill Company EMPIRE Log By Williams

ent USAF McGuire Driller ________ Field Book No. ________

Job No. ________ Date Began 6 March 85 End 6 March '85 Log Date 6 March '85

ll Method Hollow Stem Auger Rig CME-75

Sampling Method 24" Split Spoon No. Samples ________ Total Depth 12'

Lithology	Depth	Sample No.	Interval	Recovery		Description	HNU Spoon Spoons	Remarks HNU
		1ES	18"	3/6 4/6		0-.4' Topsoil .4-1' Brown SILT, sandy. 1-1.5' SAND, fine, silty.	Background 0.3 0.3	
	2							
	5	2ES 1RFW	24"	8/8 8/6		5-7' Olive brown SAND, fine to medium, some silt, damp.	19.0	2.3
	10	3ES 2RFW	24"	8/6 5/7		10-11' Olive brown SAND, clayey, damp. 11-12' Olive brown CLAY, little fine sand, damp, cohesive.	0.8	2.5
		4ES 3RFW	24"	4/3 3/4		13-14' PEAT, from black to brown with depth, damp.	0.3	3.5
	15							

BORING LOG

Page ___ of ___

Boring No. SC-8 Drill Company EMPIRE Log By Williams

Client ___ Driller ___ Field Book No. ___

Job No. ___ Date Began 6 March '25 End ___ Log Date ___

Drill Method HSA Rig ___

Sampling Method S/S No. Samples ___ Total Depth ___

Lithology	Depth	Sample No.	Interval	Recovery	Blow Counts		Description	Remarks HNU
				1"	7/10 10/13		0-.5' Topsoil. .5-1' Brown SILT, sandy. 1-1.5' SAND, fine, silty.	Background 1.0
	5			5"	10/12 20/16		5-7' Olive brown SAND, fine to medium, some silt, damp.	4.5
				6"	11/14 19/22		7-9' Olive brown SAND, fine, trace of clay, damp.	3.0
				21"	5/6 10/13		9-11' Mottled gray, and yellow brown SAND, little silt, damp, compact.	0.3
	10			19"	7/10 10/12		12-13' Gray SAND, fine to medium, clayey, wet, slightly plastic.	0.3
	15							

BORING LOG

Page____ of____

Boring No. SE-9 Drill Company ___ Log By ___

Client USAF Driller ___ Field Book No. ___

Job No. ___ Date Began ___ End ___ Log Date ___

Drill Method ___ Rig ___

Sampling Method ___ No. Samples ___ Total Depth 14'

Lithology	Depth	Sample No.	Interval	Recovery	Blow Count		Description	HNU Remarks
			0"	4/7 10/11			0-3.5' Olive gray SAND, fine to medium, damp, trace silt.	Background 0.3
	2							
	5		20"	9/10 11/7			5-7' Green gray SAND, fine to medium, damp, dense.	0.3
			21"	11/15 20/21			7-9' Green gray SAND, fine to medium, damp, trace silt, trace gravel, fine. Interbedded with .1' beds of organic Brown clay.	0.3
			21"	12/6 6/7			9-11' Orange brown SAND, fine, clayey, trace fine gravel, grading to fine SAND, some clay, damp, cohesive.	0.3
	10							
			24"	6/7 7/8			11-13' Olive brown, mottled brown SAND, fine, and CLAY, slightly plastic.	0.3
							13' Top peat layer.	
	15							

BORING LOG

Page____ of____

Boring No. SE 10 Drill Company EMPIRE Log By Williams

Client ____ Driller ____ Field Book No. ____

Job No. ____ Date Began 6 March '85 End ____ Log Date ____

Drill Method ____ Rig ____

Sampling Method ____ No. Samples ____ Total Depth 14'

Lithology	Depth	Sample No.	Interval	Recovery	Blow Count		Description	Remarks (HNU)
					4/7 5/7		0-2' Green gray SAND, fine to medium.	0
	5				12/[illegible] 10/9		5-7' Green gray SAND, fine. .1' CLAY, damp.	0
					12/11 11/15		7-9' Green gray SAND, fine to medium, grade to fine SAND, some clay, some silt, mottled with red and brown, damp.	0
					10/10 10/12		9-11' Green Brown SAND, fine, silt, damp, dense.	
	10				8/7 6/7		11-13' Green SAND, medium,	0

ORING LOG

Page ___ of ___

Boring No. SB 11 ___ Drill Company ___ Log By ___

Client ___ Driller ___ Field Book No. ___

Job No. ___ Date Began ___ End ___ Log Date ___

Drill Method ___ Rig ___

Sampling Method ___ No. Samples ___ Total Depth 14'

Lithology	Depth	Sample No.	Interval	Recovery	Blow Counts		Description	HNU Spoon	Remarks	HNU Jar
			1'	2/4 2/4			0-.5' fill .5-2' Light green brown, with slight rust mottling SAND, fine, damp, loose.	0		0
			20"	13/14 14/15			5-6.25' Light green brown, with slight rust mottling SAND			0
			22.5"	10/11 13/15			7-9' Black and gray brown mottled SAND fine and CLAY, damp, dense.	0		
			24	7/9 8/6 6/6			9-11' gray brown SAND, fine with little CLAY, organic black SAND, SILT, medium brown SAND, GRAVEL, SILT, fine to medium, damp.			
			24"	7/6			11-12' Green to brown SAND, fine to medium, some SILT and CLAY, organic, plastic. 12-13' Green SAND, medium, grades from little clay to clean, wet, firm.			

BORING LOG

Page____ of____

Boring No. SE 12 Drill Company ____ Log By ____

Client ____ Driller ____ Field Book No. ____

Job No. ____ Date Began ____ End ____ Log Date ____

Drill Method ____ Rig ____

Sampling Method ____ No. Samples ____ Total Depth ____

Lithology	Depth	Sample No.	Interval	Recovery	Blow Counts		Description	HNU Remarks
	2	1ES		18"	2/3 4/4		0-2' Green gray SAND, fine, clean, little silt, damp, loose.	0
	5			18"	14/15 14/17		5-7' Gray green SAND, fine to medium, damp.	0
				22"	13/19 20/25		7-9' Black SAND, medium to fine, gravel, silt.	0
	10			21"	3/3 3/4		9-11' Black SAND, medium to fine grades to green black SAND, fine, some clay, damp, firm.	0
				8"	5/7 7/7		11-13' Green black SAND, medium, little clay, moist.	0
	15							

BORING LOG

Page ___ of ___

Boring No. SE 13 Drill Company ___ Log By ___

Client ___ Driller ___ Field Book No. ___

Job No. ___ Date Began ___ End ___ Log Date ___

Drill Method ___ Rig ___

Sampling Method ___ No. Samples ___ Total Depth 14'

Lithology	Depth	Sample No.	Interval	Recovery	Blow Count		Description	HNU	Remarks
			4"	1/2 2/4			0-2' Brown SAND, medium, GRAVEL and SILT, moist, firm	0	
	2	1E							
	5	2E	24"	12/12 16/18			5-7' Olive green SAND, fine and CLAY, tight, damp grades to silt with trace of fine, crg. brown SAND, damp. cohesive.	0	
		3E	24"	6/8 8/6			7-9' Organic brown SILT, sandy, fine, trace SAND, medium to coarse, slightly plastic, damp.	0	
		4E	22"	4/6 6/9			9-10.5' Olive brown mottled SAND, fine, silty, damp.	0	
	10			10/11			10.5-11' White gray SAND, fine, clean, loose, damp.	0	
		5ES		15/15			11-13' Gray SAND, fine, wet, loose. Grades to white SAND, fine to coarse, clean, with trace of fine GRAVEL.	0.9	
		1RFN							
	15								

BORING LOG

Page____ of____

Boring No. SP 14 Drill Company EMPIRE Log By____

Client ____ Driller ____ Field Book No.____

Job No. ____ Date Began____ End____ Log Date ____

Drill Method____ Rig____

Sampling Method____ No. Samples____ Total Depth 14'

Lithology	Depth	Sample No.	Interval	Recovery	Blow Count		Description	HNU Remarks
				4"	2/3 4/3		0-2' Coarse Gr. like RR slag	0.0
	2							
	5			20"	8/13 9/12		5-7' Gray brown, mottled SILT, little fine sand, damp, tight. Grades to Yellow brown SAND, silty, damp, loose.	0.0
				21"	10/12 12/15		7-8' White SAND, fine, clean, damp, loose. Grades to:	
				21"	4/4 5/9		8-9' Mottled green brown to yellow brown SAND, silty, fine, with trace of fine to medium GRAVEL, damp.	0.2
	10	IRFW					9-10' Yellow brown-gray mottled CLAY, moist, very plastic.	
				14"	9/12 11/14		10-11' Gray CLAY, sandy, fine, slightly plastic, wet. Trace sand, medium to coarse.	0.6 2.0
	15							

ORING LOG Page___ of___

Boring No. SP 15 Drill Company ___ Log By ___

ent ___ Driller ___ Field Book No. ___

No. ___ Date Began 6 March 85 End 6 March 85 Log Date ___

Method ___ Rig ___

Sampling Method ___ No. Samples ___ Total Depth 15'

Lithology	Depth	Sample No.	Interval	Recovery			Description	HNU	Remarks
				15"	2/4 6/9		0-2' Mottled yellow brown SAND, clayey, wet.	0	
	2								
	5			16"	8/13 25/50		5-5.5' COAL ASH, black, damp, loose	0	
							5.5-7' Mottled SAND, fine, little silt, damp.		
				15"	11/32		7-9' Mixed ASPHALT-GRAVEL, black SAND, fine to coarse, dry.		
					1/3 2/3		9-11' Black organic CLAY with some sands, fine, damp.		
	10								
							11-12' Black SLUDGE, clayey, sandy, fine.	50.0	
					10/3 3/6		12-13' Red brown SAND, silty.		
							slight fuel odor.	80.0	
	15								

BORING LOG

Page____ of____

Boring No. SB 16 Drill Company EMPIRE Log By____

Client ____ Driller ____ Field Book No.____

Job No. ____ Date Began 7 March '88 End____ Log Date ____

Drill Method____ Rig____

Sampling Method____ No. Samples____ Total Depth 15'

Lithology	Depth	Sample No.	Interval	Recovery			Description	HWU Remarks
		1ES		20"	4/6 8/8		0-.6' Yellow SAND, fine to medium .6-1' Brown SAND, gravelly 1'-1.4' Black and brown SAND, fine, trace of silt 1.4-1.7' Reddish brown SAND, fine to medium, greenish tint, trace gravel.	0.0
	5	2ES		20"	10/13 5/8		5-6' Reddish brown SAND, fine to medium, faintly mottled. 6-6.3' Gray SAND, fine, some clay. 6.3-6.7' Olive CLAY, silty, trace of fine sand.	0.0
		3ES		24"	4/6 5/6		7-7.6' Reddish brown SAND, silty, mottled, loose. 7.6-8.5' Brown SILT, fine, sand, trace gravel. 8.5-9' Olive CLAY, silty, cohesive, moist.	0.0
	10			18"	2/2 3/3		9-10' Olive CLAY, silty, moist, cohesive, 10-10.5' Black PEAT, non-cohesive.	0.0
				16"	3/4 4/6		11-12.5' Black PEAT, high organics, damp, non-cohesive.	0.0

BORING LOG

Page ___ of ___

Boring No. SE 17 Drill Company ___ Log By ___

Client ___ Driller ___ Field Book No. ___

Job No. ___ Date Began 7 March '86 End ___ Log Date ___

Drill Method ___ Rig ___

Sampling Method ___ No. Samples ___ Total Depth ___

Lithology	Depth	Sample No.	Interval	Recovery	Blow Counts		Description	HNU Remarks
				24"	2/4 4/6		0-.5' Yellowish brown SAND, faintly mottled, fine to medium.	0.0
	2						.5-1.5' Black FLY ASH/COAL CHIPS, non-cohesive.	
							1.5-1.8' Olive SAND, silty, dry.	0.0
							1.8-2' Reddish brown SAND, medium, trace of gravel, non-cohesive.	
	5			20"	8/11 10/10		5-6.3' Olive SAND, medium, wet.	0.0
							6.3-6.7' olive brown SILT, sandy, moist, with some gravel.	
				24"	11/12 12/18		7-8' Olive SAND, silty, wet, trace of gravel.	0.0
							8-9' Olive brown SILT, fine, sandy.	
				18"	10/8 8/7		9-9.7' Olive brown SILT, fine, sandy, trace of gravel.	0.0
	10						9.7-10.5' Black and brown SILT, high organics, non-cohesive (peat).	
				20"	11/10 13/17		11-11.5' Brown SILT, fine, sandy	0.0
							11.5-12.6' whitish gray SAND, fine, clean, some roots.	
	15							

BORING LOG

Page ___ of ___

Boring No. SB-18 Drill Company ______ Log By ______

Client ______ Driller ______ Field Book No. ______

Job No. ______ Date Began ______ End ______ Log Date ______

Drill Method ______ Rig ______

Sampling Method ______ No. Samples ______ Total Depth 14'

Lithology	Depth	Sample No.	Interval	Recovery	[illegible]		Description	HNU	Remarks
		SB1	20"	3/5			0-.3' Brownish yellow SAND, medium, dry.		
				8/10			.3-1' Black SAND (FLY ASH) fine, dry, non-cohesive.	5.0	
	2	RFW 0-2					1-1.6' Brown & black SAND, silty, roots, gravel.		
							1.6-1.8' Reddish brown SAND, medium, with some silt.		
	5		18"	9/11			5-5.6' Olive SAND, fine, trace of silt.	0.0	
				13/10			6'-6.5' Olive brown SILT, sandy, fine, compacted.		
			24"	10/10			7-7.3 Olive SAND, medium, some silt.		
				12/14			7.3-8' Olive, faintly mottled SILT, fine, sandy.	0.0	
							8-8.5' Olive SAND, medium, moist, non-cohesive.		
	10						8.5-9' Brownish red SILT, trace of SILT, fine.	0.0	
			20"	3/3			9-10.5' Olive brown SILT, clayey, some fine sand, moist, slightly cohesive.		
				3/4			10.5-10.8' Black PEAT, high organics.		
			16"	6/7			11-11.3' PEAT		
				10/12			11.3-11.5' Green SAND, medium, moist.		
							11.5-12.2' Reddish brown SAND, medium to coarse, trace of gravel.		
	15						12.2-12.5' Whitish gray SAND medium, clean, moist to wet.		

ORING LOG

Page____ of____

E ing No. SC 19 Drill Company ____ Log By ____

ent ____ Driller ____ Field Book No. ____

J No. ____ Date Began 7 March '85 End ____ Log Date ____

I Method ____ Rig ____

Sampling Method ____ No. Samples ____ Total Depth ____

Lithology	Depth	Sample No.	Interval	Recovery			Description	HNU	Remarks
			15"	5/5 3/9			0-.3' Black SILT, sandy, high organics. .3-1.3' Reddish brown SAND, medium, trace of silt, mottled at 1'.	0.0	
	2						4' Wet.		
	5		20"	3/3 5/13			5-7' Olive SILT, fine, sandy, grading to silty sand.	0.0	
			24"	8/9 9/13			7-9' Olive SAND, medium, moist grading to wet at 8'.	0.0	
			20"	2/3 3/4			9-10' Olive SAND, medium, wet, trace of silt.	0.0	
	10						10'-10.8' PEAT, high organics, some silt.		
			20"	2/3 3/5			11-11.8' Olive interbedded PEAT and SAND, medium, saturated.		
							11.8-12.5' Reddish brown SILT, some roots, trace fine sand.	0.0	
							12.5-12.8' Whitish gray SAND, fine.		
	15								

BORING LOG

Page____ of____

Boring No. SP 20 Drill Company ____ Log By ____

Client ____ Driller ____ Field Book No. ____

Job No. ____ Date Began 7 March '85 End ____ Log Date ____

Drill Method ____ Rig ____

Sampling Method ____ No. Samples ____ Total Depth 11'

Lithology	Depth	Sample No.	Interval	Recovery	Blow Cts.	Description	HNU Remarks
				24"	4/6 6/5	0-1.8' Reddish brown SAND, medium, barely moist.	0.0
	2					1.8'-2' Olive brown SAND, medium, barely moist.	
	5			24"	6/8 10/12	5-7' Olive brown SAND, fine to medium, trace of silt, grades to olive color.	0.0
				18"	4/6 6/5	7-9' Olive SAND, medium, trace of silt and clay, grading to sandy, silty clay, fine, very plastic	0.0
				24"	1/1 1/1	9-10.5' Olive SAND, medium to coarse, very wet.	
	10					10.5-11' Black PEAT, fine, sandy SILT, trace very fine sand.	0.0
	15						

BORING LOG

Page____ of____

Boring No. SE 21 Drill Company ____ Log By ____

Client ____ Driller ____ Field Book No. ____

Job No. ____ Date Began 7 March 85 End ____ Log Date ____

Drilling Method ____ Rig ____

Sampling Method ____ No. Samples ____ Total Depth 12'

Lithology	Depth	Sample No.	Interval	Recovery	Blow Count	Description	HNU	Remarks
			20"	2/3 3/5		0-2' Reddish brown SAND, medium silty, grading to coarse SAND with some gravel.	0.0	
	5		20"	7/8 10/10		5-7' Olive brown SILT, fine, sandy, grading to grayish white SAND, medium, with trace of silt and gravel.	0.0	
			24"	6/6 6/7		7-7.8' Whitish gray SAND, medium to coarse.		
						7.8-9' Distinct change to Black and brown SILT, sandy with some organics.	0.0	
	10		23"	2/3 8/11		9-9.7' Black PEAT, few organics, trace of fine SAND.		
						9.7-11' SAND, medium to coarse, some gravel and silt, grading to grayish white SAND, gravelly, coarse.	0.0	
	15							

BORING LOG

Page____ of____

Boring No. SE 22 Drill Company ____ Log By ____

Client ____ Driller ____ Field Book No. ____

Job No. ____ Date Began 7 March 85 End ____ Log Date ____

Drill Method ____ Rig ____

Sampling Method ____ No. Samples ____ Total Depth 12'

Lithology	Depth	Sample No.	Interval	Recovery	Blow Count	Description	HNU Remarks
	0–2			16"	2/3 11/16	0-2' Yellowish brown SAND, medium, grading to SAND, coarse, and gravel (Boulder).	0.0
	5			20"	5/5 6/6	5-7' Grayish brown SAND, fine, moist, grading to white SAND, fine (peat in bottom of spoon).	0.0
				24"	3/3 4/4	9-9.8' Light brown SILT, fine, sandy.	0.0
	10			24"	1/1 2/2	9.8'-10.3' PEAT (Black silt, trace of fine sand).	
						10.3'-11' SAND, coarse, some gray GRAVEL, peat in bottom of spoon.	0.0
	15						

BORING LOG

Page 1 of

Boring No. SB 23 Drill Company Log By

Client Driller Field Book No.

Job No. Date Began 7 March 85 End Log Date

Drill Method Rig

Sampling Method No. Samples Total Depth 15'

Lithology	Depth	Sample No.	Interval	Recovery	Blow Counts		Description	HNU	Remarks
			12"	2/4 5/10			0-2' Yellow brown SAND, medium, grading to olive brown SAND, medium, trace of silt.	0.0	
	2								
	5		21"	3/4 6/8			5-7' Olive brown SAND, fine, silty, grades to white SAND, clean, fine, with trace of coarse SAND, damp, yellow brown, faint mottling.	0.0	
			16"	7/8 10/7			7-9' White SAND, fine, clean, moist, trace silt at bottom of spoon.		
			12"	2/2 3/2			9-11' Gray SAND, fine, clean, wet, grading to SAND, fine, silty, brownish yellow.	0.0	
	10								
			0"	3/4 3/8			11-13' Olive green SILT, fine, sandy, damp.	0.0	
	15								

BORING LOG

Page____ of____

Boring No. SB 24 Drill Company [illegible] Log By [illegible]

Client ____ Driller ____ Field Book No. ____

Job No. ____ Date Began [illegible] End ____ Log Date ____

Drill Method ____ Rig ____

Sampling Method ____ No. Samples ____ Total Depth 15'

Lithology	Depth	Sample No.	Interval	Recovery	Blow Count		Description	HNU Remarks
		RFW-SB		16"	3/5 5/7		.5-2.5' Black SAND & GRAVEL, grading to olive SAND, medium, and reddish brown SAND, some mottling.	5.0
	5			22"	5/10 15/17		5-7' Olive SAND, wet, grading to SILT, highly compacted, with some brown SAND, fine.	50.0
				22"	11/16 17/0		7-7.3' Brown SILT, trace SAND, fine. 7.3-7.5' Black SILT, some organics. 7.5-8' Olive brown SILT, trace SAND, fine. 8-9' Yellowish brown SAND, medium, trace gravel.	~100.0
	10			17"	6/5 5/4		9-11' Whitish gray SAND, fine, trace of silt, grading to highly mottled whitish gray SAND, fine, at 10'.	45.0
				18"	4/5 5/6		11-11.8' Olive brown, mottled SAND, fine. 11.8-12.2' Gray SAND, fine, moist, with CLAY. 12.2-12.5' Pale reddish brown SAND, silty, very fine.	150.0
	15							

ORING LOG

Page___ of___

ing No. SR-25 Drill Company ___ Log By ___

ent ___ Driller ___ Field Book No. ___

No. ___ Date Began 8 March '85 End ___ Log Date ___

Method ___ Rig ___

Sampling Method ___ No. Samples ___ Total Depth 15'

Lithology	Depth	Sample No.	Interval	Recovery		Description	HNU Remarks
			12"	3/5 5/7		0-2' Brownish Yellow SAND, medium, with 5" seam of black, silty SAND, fine (FLY ASH).	2.2
	2						
	5		18"	10/3 10/9		5-7' Olive green SAND, medium, some silt, grading to olive brown CLAY, sandy, some silt.	
			22"	11/11 10/9		7-9' Olive brown SILT, fine, sandy, becoming moist to wet at bottom of spoon where there is also a trace of roots.	50.0
	10		18"	3/3 3/5		9-11' PEAT @ 10'; product seems to be concentrated in peat layer. Strong JP-4 odor. Olive brown SAND, silty, fine.	75.0
				9/11 9/9		11-13' Gray SAND, clayey, grading to CLAY, sandy, some silt, slightly cohesive.	35.0
	15					15-16' Gray SAND, medium, uniform, moist to wet.	20.0

BORING LOG

Page ___ of ___

Boring No. SB-26 Drill Company ___ Log By ___

Client ___ Driller ___ Field Book No. ___

Job No. ___ Date Began 5 March '85 End ___ Log Date ___

Drill Method ___ Rig ___

Sampling Method ___ No. Samples ___ Total Depth 15'

Lithology	Depth	Sample No.	Interval	Recovery	Blow Count		Description	HNU	Remarks
				20"	4/7 5/7		0-2' Yellowish brown SAND, medium, with black sand, (Fly Ash) fine, silty, coal chips at 8"-12".	3.0	
	5			20"	5/6 7/10		5-7' Olive green SAND, medium, grading to SILT, sandy, tightly packed with some clay and wood chips.		
				18"	6/7 7/5		7-9' Olive brown SILT, fine, sandy, grading to CLAY, fine, sandy, moist, cohesive.	0.6	
	10			18"	2/2 4/5		9-11' Olive brown SILT, fine, sandy, peat at 8"-18" with strong JP-4 odor.	50.0	
				10"			11-12' PEAT, sheen visible.		
							12-13' Olive green SAND, medium, some gravel.	50.0	
				24"	9/9 10/10		13-14.8' Olive green SAND, medium trace of gravel, very wet.	40.0	
	15						14.8-15' Olive green SAND, coarse, very wet.		

ORING LOG

Page ___ of ___

ing No. SC 27 Drill Company ______ Log By ______

ent ______ Driller ______ Field Book No. ______

No. ______ Date Began 8 March '85 End ______ Log Date ______

Method ______ Rig ______

Sampling Method ______ No. Samples ______ Total Depth 13'

Lithology	Depth	Sample No.	Interval	Recovery		Description	HNU	Remarks
			24"	3/2 2/2		0-.3' Yellow brown SAND, medium .3-2' Fly Ash and coal chips.	0.0	
	5		24"	2/2 3/2		5-6' Olive green SAND, medium. 6-7' Olive brown SILT, fine, sandy, slightly moist, tightly compacted	1.2	
			24"	4/4 5/4		7-8.5' Olive brown SILT, fine, sandy, moist. 8.5-9' Black SILT, fine, sandy, high organics (peat).	1.0	
	10		21"			9-9.8' Black SILT, fine, sandy, high organics. 9.8-11' Gray SAND, fine, with some silt.	15.0	
			21"	7/8 7/9		11-13' GRAY SAND, medium, very wet.	0.0	
	15							

BORING LOG

Page____ of____

Boring No. SB-28 Drill Company ____ Log By ____

Client ____ Driller ____ Field Book No. ____

Job No. ____ Date Began 8 March 85 End ____ Log Date ____

Drill Method ____ Rig ____

Sampling Method ____ No. Samples ____ Total Depth 14'

Lithology	Depth	Sample No.	Interval	Recovery		Description	HNU Remarks
			18"	4/12		0-.3' Yellowish brown SAND, medium.	
				8/7		.3-.7' Fly ASH (coal chips).	0.2
	2					.7-.8 Yellow SAND (medium)	
						.8-1.5' Olive brown SAND, medium.	
	5		24"	11/8 8/10		5-7' Brown SAND, medium, gravelly, grading to grayish white SAND, fine, clean.	0.0
			24"	6/5 7/5		7-9' Gray SAND, medium, trace of silt, slightly moist, faint mottles	0.0
			9"	3/5 5/4		9-11' White SAND, medium to coarse, clean, interbedded with pale red CLAY, sticky, trace of fine SAND.	0.0
	15						

BORING LOG

Page____ of____

Boring No. SB 29 Drill Company ____ Log By ____

Client ____ Driller ____ Field Book No. ____

Job No. ____ Date Began 8 March '85 End ____ Log Date ____

Drilling Method ____ Rig ____

Sampling Method ____ No. Samples ____ Total Depth 14'

Lithology	Depth	Sample No.	Interval	Recovery			Description	HNU spoon	Remarks HNU Jar
				8"	4/7 5/7		0-2' Olive brown SAND, silty; FLY ASH; AND Brown SAND, silty mixture.	0.0	
	2	RFW 5-7		20"	8/10 10/10		5-7' Olive SAND, silty, grading to brownish yellow SAND, fine, silty, with mottles.	0.0	8.0
	5	7-8 8-9		24"	6/8 10/10		7-8.3' Olive SAND, fine, silty. 8.3-9' Black SAND, fine, silty, fly ash (strong odor).	20.0	60.0 65.0
					2/2 3/3		9-11' No Recovery		
	10	RFW 11-13		15"	13+B 1'		11-13' Gray CLAY, sandy, with some silt, very wet. Grades to brown SAND, fine, silty, moist.	5.0	75.0
	15								

BORING LOG

Page___ of___

Boring No. SB-20 Drill Company ___ Log By ___

Client ___ Driller ___ Field Book No. ___

Job No. ___ Date Began 8 March '85 End ___ Log Date ___

Drill Method ___ Rig ___

Sampling Method ___ No. Samples ___ Total Depth 14'

Lithology	Depth	Sample No.	Interval	Recovery	Blow Counts		Description	HNU Remarks
				9"	2/3 2/6		0-.5' Topsoil. .5-2' Yellow brown SAND, fine to coarse, silty, loose, damp.	0.3
	5			16"	4/6 8/11		5-7' Tan gray SAND, fine to coarse, clean, laminated with dark banding, damp, loose.	1.0
				17"	10/12 12/14		7-9' SAND, fine to coarse, clean, trace of fine gravel, loose, damp, dark gray laminated.	2.0 odor
				18"	6/11 13/18		9-11' Tan SAND, fine to coarse, wet, loose.	2.0 odor
	10			13"	15/20 22/26		11-13' SAND, fine to coarse, clean, damp, loose, grading to Gray SAND, fine to coarse and GRAVEL, fine to coarse. Dark Gray staining at 12.3-12.6'. Some fine to coarse gravel, wet.	60.0 odor (strong)
	15							

WESTON

MANAGERS DESIGNERS CONSULTANTS

APPENDIX E

FIELD SAMPLING AND QA/QC PROCEDURES AND SAFETY PLAN

1670B

APPENDIX E

FIELD SAMPLING AND QA/QC PROCEDURES

E.1 MONITORING WELL PURGING

All ground water sampling was accomplished after the installed monitoring wells were properly developed and had stabilized for a period of at least two weeks. Prior to collecting samples, each well was purged by pumping a minimum of three volumes of standing water from the well using a submersible pump. This ensured that a representative sample of the aquifer was collected during the sampling process. The field procedures used for monitoring well purging included the following guidelines:

1. Prior to placing any equipment into the well, the equipment was scrubbed with an Alconox (detergent) and water solution, and rinsed with distilled water.

2. Before purging, the depth to water from the reference measuring point on the top of the well casing was measured and recorded.

3. The volume of water to be purged was calculated, based on the amount of standing water in the well casing.

4. The well was purged by pumping, removing at least three times the calculated volume of standing water in the well casing.

5. The pump was disconnected and removed from the well. The equipment was decontaminated by scrubbing with Alconox and flushing with deionized water.

6. A sample was recovered with a Teflon bailer.

E.2 MONITOR WELL SAMPLE COLLECTION

Ground water sampling was directed toward the detection of:

1. Oil and grease

2. Volatile Organic Compounds (VOC)

All required sample containers were prepared by WESTON Laboratories in accordance with standard USEPA and U.S. Air Force supplied procedures and protocols.

After the wells were purged, sampling consisted of the following steps:

1. Samples were bailed from the well using a Teflon bailer to avoid aeration and excessive turbulence in the sample water. Between wells, the bailer was washed in a detergent solution, followed by rinses with methanol and water.

2. Appropriate containers were filled according to the analytical parameter of concern. Sample containers used were:

   - Oil and Grease - 1 liter amber glass bottles preserved with sulfuric acid.

   - VOC's - 40 ml glass vials with septum lids filled so that no air space remained.

All glass containers have Teflon-lined caps.

3. Grab samples were taken for immediate analyses in the field for pH, temperature and specific conductance.

4. The sample containers were wrapped in packaging material and placed in thermal chests packed with ice.

E.3 SOIL SAMPLING

All soil sampling accomplished using a drill rig employed the Standard Penetration Test (ASTM Method 1586) using a steel split-spoon sampler. Prior to taking each sample, the following procedures were followed:

1. The split-spoon sampler was washed thoroughly with an Alconox and water solution and with methanol, and rinsed in deionized water.

2. After assembly of the sampler, the sampler was lowered into the boring and the sample taken by the Standard Penetration Test Method.

3. Upon recovery of the sampler, the spoon was split and the sample examined for soil characteristics.

4. The sample was then cleaned of any smeared sample which might have been caused by sliding along the inside of the spoon, and the cleaned, representative sample was put in a marked and labeled 1-liter clear glass sampling jar with a screw cap.

5. Samples for analysis of Oil and Grease were stored for analysis in washed and baked sample jars of amber glass.

All soil sampling not accomplished using a drill rig was done using a stainless steel scoop. Prepared sample jars were used for taking and storing samples for pending analyses.

E.4 CHAIN-OF-CUSTODY

Since they document the history of samples, chain-of-custody procedures are a crucial part of a sampling/analysis program. Chain-of-custody documentation enables identification

and tracking of a sample from collection to analysis to reporting.

WESTON's chain-of-custody program necessitates the use of EPA-approved sample labels, secure custody, and attendant recordkeeping. Depending on the client's requirements, WESTON also offers container sealing during unattended transportation of samples. The chain of custody forms from field to laboratory are included in Appendix H.

Each time a sample is relinquished from one analyst to another or from one major location to another, WESTON's analytical personnel are required to make appropriate entries. Personnel-specific initials are used as identifiers of analysts, as are location codes for various locations (refrigerators, extraction areas, analytical areas, etc.) within the laboratory. Each transaction for each sample is accompanied by a specific reason for transfer.

WESTON

APPENDIX E
SAFETY PLAN

WORK LOCATION PERSONNEL PROTECTION
AND SAFETY EVALUATION FORM

Attach Pertinent Documents/Data

Fill in Blanks As Appropriate

WO # 06270903

Division Econ

Office Geosciences

Prepared by

Date

Reviewed by

Date

Approved by

Date

A. Work Location Description

1. Name McGuire AFB, New Jersey

2. Location TANK FARM

3. Type: HW Site ( ) Industrial ( )

Spill (X) Construction ( )

(X) Existing WESTON Work Location

( ) Existing Client Work Location

Other ( ) Describe

4. Status Active Tank Farm. Spill lines are disconnected

5. Anticipated activities: Soil Borings, monitor well installation and soil and g.w. sampling

6. Size 20 Acres

7. Surrounding Population Rural

8. Buildings/Homes/Industry MAC Base

5433A

9. Topography FLAT

10. Anticipated Weather Temperate

11. Unusual Features

12. Site History Tank Farm Rail Loading Area

B. Hazard Description

1. Background Review: Complete (X) Partial ( )

If partial, why?

2. Hazard Level: A ( ) B ( )

Unknown ( ) C ( ) D (X) possible C upgrade based on HNU

Justification Constant monitoring w/ HNU and Explosimeter

3. Types of Hazards:

A. Chemical ( ) Inhalation (X) Explosive (X)

Biological ( ) Ingestion ( ) O_2 Def. ( )

Skin Contact (X) Toxic ( )

Describe JP-4 fuel spill: flammable liquid

B. Physical (X) Cold Stress ( ) Noise ( )

Heat Stress ( ) Other ( )

WESTON

Describe Drilling Equipment

C. Radiation ( ) NONE

Describe

4. Nature of Hazards:

Air (X) Describe Volatile organic vapors B-T-X compounds

Soil (X) Describe JP-4 fuel

Surface Water ( ) Describe

Groundwater (X) Describe JP-4 fuel + dissolved B-T-X compounds

Other ( ) Describe

5435A

. Chemical Contaminants of Concern ( ) N/A

ontaminant	TLV (PPM)	I.D.L.H. (PPM)	Source/Quantity Characteristics	Route of Exposure	Symptoms of Acute Exposure	Instruments Used to Monitor Contaminant
Benzene	10 ppm		Constituents of JP-4	Air/Skin	Headache, Convulsions	HNU
Toluene	200 ppm			Air/Skin	irritant	HNU
xylene	100 ppm			Air/Skin		HNU

6. Physical Hazards of Concern ( ) N/A

Hazard	Description	Location	Procedures Used to Monitor Hazard
Heavy Equipment	Drill rig	Tank Farm	Use hard hats & safety shoes
Explosion/Fire	JP-4 fuel	Groundwater surface and soils	Explosimeter

WESTON

7. Work Location Instrument Readings Ambient, pre activity

Location TANK Farm

% O_2 ______ % LEL 0

Radioactivity ______ PID ______

FID ______ Other HNU - Background

Other ______ Other ______

Location ______

% O_2 ______ % LEL ______

Radioactivity ______ PID ______

FID ______ Other ______

Other ______ Other ______

Location ______

% O_2 ______ % LEL ______

Radioactivity ______ PID ______

FID ______ Other ______

Other ______ Other ______

Location ______

% O_2 ______ % LEL ______

Radioactivity ______ PID ______

FID ______ Other ______

Other ______ Other ______

8. Hazards expected in preparation for work assignment.

Describe: ______

WESTON

C. Personnel Protective Equipment

1. Level of Protection

A ( ) B ( ) C ( ) D (X) Location/Activity:

with upgrade to C if required. If HNU readings

~~A ( ) B ( ) C ( ) D ( ) Location/Activity:~~

in work space >5 ppm but <25 ppm Level C. >25 ppm stop work.

2. Protective Equipment (specify probable quantity required)

Respiratory

( ) SCBA, Airline

(X) Full Face Respirator (Cart. [illegible])
4

( ) Escape Mask

( ) None

( ) Other ____

( ) Other ____

Clothing

( ) Fully Encapsulating Suit

( ) Chemically Resistant Splash Suit

( ) Apron, Specify ____

(X) Tyvek Coverall

( ) Saranex Coverall

( ) Coverall, Specify ____

( ) Other ____

( ) Other ____

Head & Eye

(X) Hard Hat

( ) Goggles

( ) Face Shield

( ) Chemical Eyeglasses

( ) None

(X) Other Steel Toe Shoes

Hand Protection

(X) Undergloves Surgical
Type

(X) Gloves Butyl
Type

( ) Overgloves ____
Type

( ) None

( ) Other ____

Foot Protection ( ) N/A

(X) Safety Boots

( ) Disposable Overboots

( ) Other ______________

3. Monitoring Equipment ( ) N/A

( ) CGI

( ) O$_2$ Meter

( ) Rad Survey

( ) Detector Tubes

Type: HNU

Explosimeter

( ) PID

( ) FID

( ) Other ______________

( ) Other ______________

D. Personnel Decontamination (Attach Diagram)

Required ( ) Not Required (X)

Equipment Decontamination (Attach Diagram)

Required (X) Not Required ( )

If required, describe and list equipment

Sampling equipment will be washed in detergent water and rinsed with deionized water and methanol. Equipment wash and rinse pans, paper towels, wash bottles, plastic sheeting, detergent (Alconox) and methanol.

5435A

WESTON

E. Personnel

	NAME	WORK LOCATION TITLE/TASK	MEDICAL CURRENT	FIT TEST CURRENT
1.	John Williams		(✓)	(✓)
2.	[illegible] Johnson		(✓)	(✓)
3.	Judith Jordan		(✓)	(✓)
4.	Gary Witmar		(✓)	(✓)
5.	Bruce Benish		(✓)	(✓)
6.			( )	( )
7.			( )	( )
8.			( )	( )
9.			( )	( )
10.			( )	( )

Site Safety Co-ordinator John Williams

F. <u>Activities Covered Under this Plan</u>

Task No.	Description	Preliminary Schedule
1	Drilling/well Installation	4-29 March, 1985
2	G.W Sampling	8-12 April, 1985
		22-26 April, 1985

G. Subcontractor's Health and Safety Program Evaluation ( ) N/A

Name and Address of Subcontractor: Empire Soils Investigations Inc

Activities to be Conducted by Subcontractor: Drilling and well installation

EVALUATION CRITERIA

Item	Adequate	Inadequate	Comments
Medical Surveillance Program	(✓)	( )	
Personal Protective Equipment Availability	(✓)	( )	
On-Site Monitoring Equipment Availability	(✓)	( )	Weston will monitor
Safe Working Procedures Specification	( )	( )	
Training Protocols	( )	( )	
Ancillary Support Procedures (if needed)	( )	( )	
Emergency Procedures	( )	( )	
Evacuation Procedures Contingency Plan	( )	( )	
Decontamination Procedures Equipment	(✓)	( )	Steam cleaner rig
Decontamination Procedures Personnel	( )	( )	

GENERAL HEALTH AND SAFETY PROGRAM EVALUATION: ADEQUATE (✓) INADEQUATE ( )

ADDITIONAL COMMENTS:

EVALUATION CONDUCTED BY: [signature] DATE:

WESTON

H. Contingency Contacts

Agency	Contact	Phone Number
Fire Department	Base Bldg 1708	609-724-3151
Police Department	" " 1814	724-2001
Health Department	Base Clinic	724-3865
Poison Control Center		1-800-962-1253
State Environmental Agency		
EPA-Regional Office		
EPA-ERT. ICOM		
Spill Contractor		
State Police		
F.A.A.		
Civil Defense		
On Site Coordinator		
Site Telephone	None	
Nearest Telephone	Airport Terminal - McGuire Blvd. (Location)	
Other Base BEE	Cpt Torgle	721 4174

I. Contingency Plans

Spill, Accidental Release; Describe Notify Base Bioenvironmental office

Fire Explosion; Describe Notify Base Fire Dept.

Other; Describe

Exit Routes, Communication Systems; Describe Exit to SE or NW

WESTON

MEDICAL EMERGENCY

Name of Hospital Base Emergency Services

Address: ______ Phone No. ______

Name of Contact ______

Address: ______ Phone No. ______

Route to Hospital: (Attach Map) ______

______

______

______

______

Travel Time From Site (Minutes) ______

Distance to Hospital (Miles) ______

Name/Number of 24 Hr. Ambulance Service ______

______

WESTON

HEALTH AND SAFETY PLAN
APPROVAL/SIGN OFF FORMAT

I have read, understood, and agreed with the information set forth in this Health and Safety Plan (and attachments) and discussed in the Personnel Health and Safety briefing.

Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
John A Williams Site Safety Co-ordinator	Signature	3/1/85 Date
Director, Corporate Health and Safety	Signature	Date
Richard C Johnson ~~Project~~ Manager Task	Signature	3/1/85 Date
Project Director/ Department Manager	Signature	Date

Personnel Health and Safety Briefing Conducted By:

Name	Signature	Date

APPENDIX F

CALCULATIONS

WESTON

APPENDIX F

CALCULATIONS

Method Used for Finding Corrected Depths to Water (DTW)

The following formula was used to calculate the peizometric surface elevation in wells MW-12, MW-18, MW-19, and MW-21 whose water table surface is depressed by floating fuel product:

(measured depth to water) - (product thickness x 0.7) =

corrected depth to water (0.7 is the approximate relative density of fuel)

Example: MW-12

measured DTW = 17.25 ft
product thickness = 4.77 ft

(measured DTW) - (product thickness x 0.7) = corrected DTW
(17.25 ft) - (4.77 ft x 0.7) = 13.9 ft

Floating Fuel Volume Calculation

Calculations of fuel volume in the groundwater table are rough and provide an estimate only. The following simplifying assumptions are made:

- Porosity is 0.25 for the dense, medium sandy materials underlying the facility.
- Pore space is saturated within the thickness of the product layer.
- Product thicknesses measured in well bores are four times the true product thicknesses in the aquifer.
- The thickness of the product layer is uniform within the areal extent of the plume.

WESTON

The observed thickness of an oil layer floating on water in a borehole is generally greater than the actual thickness of the product layer in the aquifer. This is due to differences in densities between air, water, and oil (fuel product) and differences in capillary pressures between water and oil and oil and air (de Pastrovich, et al., 1979). If the assumption is made that the capillary pressure differences between water and oil and between oil and air are approximately the same, which is true "more often than not" (de Pastrovich, et al., 1979), then the height of the product in the borehole will be approximately four times the true thickness of the product layer in the aquifer (de Pastrovich, et al., 1979).

These assumptions were made and a multiplier of 0.25 was used to determine true thicknesses of the product layers in the following calculations.

Calculations:

V_f = T_p x A x n (see Subsection 4.1.3 for discussion of equation)

V_f = Volume of floating fuel product
T_p = Corrected thickness of fuel layer
A = Area of plume
n = Porosity of aquifer

- Large Plume

T_p = 5.15 x 0.25 = 1.29 ft
A = 149 ft x 83 ft = 12,367 sq ft
n = 0.25

V_f = 1.29 ft x 12,367 sq ft x 0.25 = 3,988.4 cu ft = 29,833.2 gallons

- Small Plume

T_p = 5.00 ft x 0.25 = 1.25 ft
A = π (10.6 ft)^2 = 353 sq ft
n = 0.25

V_f = 1.25 ft x 353 sq ft x 0.25 = 110.3 cu ft = 825.1 gallons

References Cited

de Pastrovich, T.L., Y. Baradat, R. Barthel, A. Chiarelli, and D.R. Fussell; 1979, Protection of Groundwater from Oil Pollution; CONCAWE's Water Pollution Special Task Force No. 11; April 1979; Den Haag.

APPENDIX G

LABORATORY DATA

1670B

WESTON

DATE OF REPORT: APRIL 17, 1985

McGUIRE A.F.B.
OIL & GREASE SUMMARY REPORT
FOR SOIL SAMPLES
REC'D. MARCH 18 AND 19, 1985
W.O. NO. 0628-09-03-00

EPA METHOD 413.2

R.F.W. NO.	SAMPLE DESCRIPTION	DATE COLLECTED	DATE ANALYZED	OIL&GREASE µg/g
8503-287-0010	SB-1 5-7'	3/6/85	3/27/85	5,030
-0020	SB-1 10-12'	3/6/85	3/27/85	1,650
-0030	SB-2 5-7'	3/6/85	3/27/85	162
-0040	SB-2 10-12'	3/6/85	3/27/85	43
-0050	SB-3 5-7'	3/6/85	3/27/85	69
-0060	SB-3 10-12'	3/6/85	3/27/85	7,780
-0070	SB-4 5-7'	3/6/85	3/27/85	71
-0080	SB-4 10-12'	3/6/85	3/27/85	39
-0090	SB-5 0-2'	3/6/85	3/27/85	5,630
-0100	SB-5 5-7'	3/6/85	3/27/85	245
-0110	SB-6 5-7'	3/6/85	3/27/85	157
-0120	SB-6 10-12'	3/6/85	3/27/85	245
-0130	SB-7 5-7'	3/6/85	3/27/85	224
-0140	SB-8 7-9'	3/7/85	3/27/85	157
-0150	SB-10 5-7'	3/7/85	3/27/85	90
-0160	B-11 COMPOSITE	3/7/85	3/27/85	142
-0170	B-12 COMPOSITE	3/7/85	3/27/85	299
-0180	B-13 COMPOSITE	3/7/85	3/27/85	36
-0190	SB-14 0-11'	3/7/85	3/27/85	32
-0200	B-14 11-13'	3/7/85	3/27/85	130
-0210	B-15 11-13'	3/7/85	3/27/85	820
-0220	B-16 0-13'	3/7/85	3/27/85	106
-0230	B-17 0-13'	3/7/85	3/27/85	180
-0240	B-18 0-2'	3/7/85	3/27/85	306
-0250	B-18 5-13'	3/8/85	3/27/85	96
-0260	B-19 0-13'	3/8/85	3/27/85	47
-0270	B-20 0-13'	3/8/85	3/27/85	114
-0280	B-21 0-11'	3/8/85	3/27/85	67
-0290	B-22 0-11'	3/8/85	3/27/85	172
-0300	B-23 0-11'	3/8/85	3/27/85	39
-0310	SB25 5-7'	3/8/85	3/27/85	70
-0320	SB25 9-11'	3/8/85	3/27/85	9,170
-0330	S 26 5-7'	3/8/85	3/27/85	160
-0340	B-26 9-11'	3/8/85	3/27/85	12,000
-0350	B-24 7-9'	3/8/85	3/27/85	102

WESTON

DATE OF REPORT: APRIL 17, 1985

McGUIRE A.F.B. (CON'T.)

R.F.W. NO.	SAMPLE DESCRIPTION	DATE COLLECTED	DATE ANALYZED	OIL&GREASE µg/g
8503-287-0360	B-24 11-13'	3/8/85	3/27/85	566
-0370	B-27 0-11'	3/8/85	3/27/85	102
-0380	B-27 11-13'	3/8/85	3/27/85	84
-0390	SB28 0-11'	3/8/85	3/27/85	49
-0400	SB29 5-7'	3/8/85	3/27/85	26
-0410	SB29 8-9'	3/8/85	4/11/85	1,730
-0420	SB30 0-11'	3/8/85	3/27/85	32
-0420 DP	SB30 0-11" DUP.	3/8/85	3/27/85	27
-0430	SB30 11-13'	3/8/85	3/27/85	184
8503-287-0000	LAB BLANK	------	3/27/85	22
-0000 DP	LAB BLANK DUP.	------	3/27/85	27
8503-291-0030	MW TF20 5-15'	3/11/85	3/27/85	37
-0060	MW TF23 5-22'	3/11/85	3/27/85	98

NOTE: THERE ARE NO TABULATED EPA RECOMMENDED HOLDING TIMES FOR SOIL SAMPLES.

Approved By: Earl M. Hansen

Earl M. Hansen, Ph.D.
Manager
WESTON Analytical Laboratories

WESTON

DATE OF REPORT: April 15, 1985

McGuire A.F.B.
OIL AND GREASE SUMMARY REPORT
FOR SOIL
SAMPLES COLLECTED MARCH 29, 1985
W.O. NO. 0628-09-03

These samples were delivered to the laboratory on April 1, 1985 by John Williams. Analysis by EPA Method 413.2 was completed on Apirl 8, 1985.

R.F.W. NO.	SAMPLE DESCRIPTION	OIL AND GREASE, ug/g
8504-357-0010	MAFB # 1A	1,180
-0020	MAFB # 2A	52
-0030	MAFB # 3A	284
-0040	MAFB # 4A	1,490
-0050	MAFB # 5A	46
-0060	MAFB # 6A	341
-0070	MAFB # 7A	52
-0080	MAFB # 8A	134
-0090	MAFB # 9A	90
-0100	MAFB # 10A	2630
-0110	MAFB # 11A	1370
-0120	MAFB # 12A	108
-0130	MAFB # 13A	3430
-0140	MAFB # 14A	52
-0150	MAFB # 15A	73
-0160	MAFB # 16A	97

APPROVED BY Earl M. Hansen

Earl M. Hansen, Ph.D.
Manager
WESTON Analytical Laboratories

WESTON

McGUIRE A.F.B.
SUMMARY REPORT
FOR
SAMPLES REC'D. APRIL 4,5,1985
W.O. NO. 0628-09-03

DATE OF REPORT: APRIL 25, 1985

I. OIL AND GREASE ANALYSIS

a)

R.F.W. NO.	SAMPLE DESCRIPTION	DATE COLLECTED	DATE REC'D	DATE ANALYZED	OIL & GREASE mg/L
8504-364-0010	TF18A	4/3/85	4/4/85	4/17/85	9300
-0020	TF19A	4/3/85	4/4/85	4/17/85	538
-0030	TF20A	4/3/85	4/4/85	4/17/85	0.26
-0040	TF21A	4/3/85	4/4/85	4/17/85	667
-0050	TF22A	4/3/85	4/4/85	4/17/85	0.26
-0060	TF23A	4/3/85	4/4/85	4/17/85	0.24
-0070	TF24A	4/3/85	4/4/85	4/17/85	6.77
-0080	TF25A	4/3/85	4/4/85	4/17/85	0.56
-0090	TF25C	4/3/85	4/4/85	4/17/85	1.05
8504-371-0010	FIELD BLANK	4/3/85	4/5/85	4/17/85	0.10
-0020	TRIP BLANK	4/3/85	4/5/85	4/17/85	0.12
-0030	STATION 1 UP-GRADIENT	4/4/85	4/5/85	4/17/85	0.30
-0040	STATION 2 DOWN-GRADIENT	4/4/85	4/5/85	4/17/85	0.37

b) These samples were analyzed by EPA METHOD 413.2 within the EPA recommended holding time of 28 days. The requested detection limit of 100 µg/L (0.10 mg/L) achieved.

II. BENZENE, TOLUENE, XYLENE, (B,T,X) ANALYSIS

a)

R.F.W.NO.	SAMPLE DESCRIPTION	DATE COLLECTED	DATE ANALYZED	BENZENE µg/L	TOLUENE µg/L	XYLENE µg/L
8504-364-0010	TF 18A	4/3/85	4/19/85	320,000	310,000	1,100,000
-0020	TF 19A	4/3/85	4/19/85	<50,000*	70,000	200,000
-0030	TF 20A	4/3/85	4/19/85	<2.0	< 2.0	< 4.0
-0040	TF 21A	4/3/85	4/19/85	<50,000*	74,000	510,000
-0050	TF 22A	4/3/85	4/19/85	<2.0	< 2.0	11
-0060	TF 23A	4/3/85	4/19/85	<2.0	< 2.0	< 4.0
-0070	TF 24A	4/3/85	4/19/85	2,200	2,100	19,000
-0080	TF 25A	4/3/85	4/19/85	<2.0	< 2.0	< 4.0
-0090	TF 25C	4/3/85	4/19/85	<2.0	< 2.0	< 4.0
-0080 DUP	TF 25A (DUP)	4/3/85	4/19/85	<2.0	< 2.0	< 4.0
8504-364/BLANK	LAB BLANK	------	4/19/85	<2.0	< 2.0	< 4.0

* - LARGE INTERFERENCE ELUTING NEAR BENZENE; MAKING DETECTION / QUANTIFICATION OF BENZENE IMPOSSIBLE IN THESE SAMPLES

Approved By: Carter P. Nulton

Carter P. Nulton, Ph.D.
Organics Supervisor
WESTON Analytical Laboratories

WESTON

DATE OF REPORT: APRIL 25, 1985

McGUIRE AFB (CON'T.) PG. 2

II. BENZENE, TOLUENE, XYLENE (B,T,X) ANALYSIS (CON'T.)

a)

R.F.W. NO.	SAMPLE DESCRIPTION	DATE COLLECTED	DATE ANALYZED	BENZENE µg/L	TOLUENE µg/L	XYLENE µg/L
8504-364/SPIKE	BLANK SPIKE	------	4/19/85	91%RECOVERY	92%RECOVERY	90%RE
8504-371-0010	FIELD BLANK	4/3/85	4/18/85	<2.0	<2.0	<4.0
-0020	TRIP BLANK A	4/3/85	4/18/85	<2.0	<2.0	<4.0
-0030	STA.1 UP-GRADIENT	4/4/85	4/18/85	<2.0	<2.0	<4.0
-0040	STA. 2 DOWN-GRADIENT	4/4/85	4/18/85	<2.0	<2.0	<4.0
-0040 DUP	STA. 2 (DUP)	4/4/85	4/18/85	<2.0	<2.0	<4.0
8504-371/BLANK	LAB BLANK	------	4/18/85	<2.0	<2.0	<4.0
8504-371/ SPIKE	LAB SPIKE	------	4/18/85	85%RECOVERY	87%RECOVERY	86%R

b) All samples were analyzed by EPA METHOD 602. Samples 8504-364-0010 to 0090 exceeded the EPA recommended holding time of 14 days from collection to analysis by 2 days. Samples 8504-371-0010 to 0020 exceeded it by 1 day.

Approved By: Earl M. Hansen

Earl M. Hansen, Ph.D.
Manager
WESTON Analytical Laboratories

DATE OF REPORT: MAY 8, 1985

McGuire A.F.B.
SUMMARY REPORT
FOR
SAMPLES REC'D APRIL 25, 1985
W.O. NO. 0628-09-03

I. ANALYSIS RESULTS

R.F.W. NO.	SAMPLE DESCRIPTION	DATE SAMPLE COLLECTED	DATE ANALYZED O/G	DATE ANALYZED B,T,X	OIL&GREASE μg/L	BENZENE μg/L	TOLUENE μg/L	XYLENE μg/L
8504-441-0010	WELL MW-12B	4-24-85	4-29-85	5-2-85	105	4,900	6,000	8,500
-0020	WELL MW-13B	4-24-85	4-29-85	5-2-85	0.28	<2.0	3.0	8.8
-0030	WELL MW-188	4-24-85	4-29-85	5-2-85	793	6,000	14,000	24,000
-0040	WELL MW-198	4-23-85	4-29-85	5-2-85	34.3	14,000	18,000	24,000
-0050	WELL MW-20B	4-24-85	4-29-85	5-2-85	0.30	<2.0	<2.0	<4.0
-0060	WELL MW-21B	4-23-85	4-29-85	5-2-85	22.4	6,000	5,900	17,000
-0070	WELL MW-22B	4-24-85	4-29-85	5-2-85	<0.10	<2.0	<2.0	<4.0
-0080	WELL MW-23B	4-24-85	4-29-85	5-2-85	0.15	<2.0	<2.0	5.7
-0090	WELL MW-24B	4-24-85	4-29-85	5-2-85	4.44	3,500	130	6,000
-0100	WELL MW-25B	4-24-85	4-29-85	5-2-85	0.40	<2.0	<2.0	<4.0
-0110	WELL 20 8LANK B	4-24-85	4-29-85	5-2-85	<0.10	<2.0	<2.0	<4.0
-0120	WELL 20 DUP B	4-24-85	4-29-85	5-2-85	0.27	<2.0	<2.0	<4.0
-0130	TRIP BLANK	4-24-85	-------	5-2-85	----	<2.0	<2.0	<4.0
8504-441-0050 DUP	LAB DUPLICATE	4-24-85	-------	5-2-85	----	<2.0	<2.0	<4.0
8504-441/	LAB BLANK	-------	-------	5-2-85	----	<2.0	<2.0	<4.0
8504-441/SPIKE	BLANK SPIKE	-------	-------	5-2-85	----	96% RECOVERY	96% RECOVERY	98% RECOVERY

Approved By: Earl M. Hansen

Earl M. Hansen, Ph.D.
Manager
WESTON Analytical Laboratories

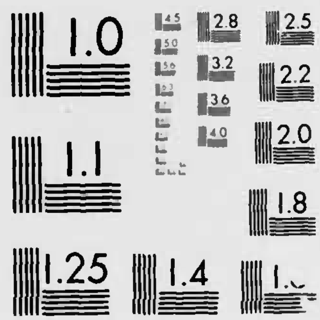
APPENDIX H

CHAIN-OF-CUSTODY

DOCUMENTS

1670B

AD-A191 022 INSTALLATION RESTORATION PROGRAM PHASE 2 3/3
CONFIRMATION/QUANTIFICATION STAG..(U) WESTON (ROY F)
INC WEST CHESTER PA J WILLIAMS ET AL. OCT 87
UNCLASSIFIED F33615-84-D-4400 F/G 24/4 NL


1.0
4.5
5.0
5.6
2.8
3.2
3.6
4.0
2.5
2.2
2.0
1.1
1.8
1.25
1.4

WESTON
001

Custody Transfer Record/Lab Work Request

Received By V.R. Dinderd Client USAF McGuire AFB RFW Contact R. Johnson
Date 3/18/85 Client Contact Date Due
Assigned to Phone Project Number 0628 0903

8503-287-

SAMPLE IDENTIFICATION					ANALYSES REQUESTED							
Sample No.	Client ID No.	Description	Date Collected	Container/Preservative	O/G BY IR							
SB-1 5-7'	0010	Soil Samples	6 March 85									
SB-1 10-12'	20											
SB-1 15-17'												
SB-2 5-7'	0030											
SB-2 10-12'	40											
SB-2 15-17'												
SB-3 5-7'	50											
SB-3 10-12'	60											
SB-3 15-17'												
SB-4 0-2'												
SB-4 5-7'	70											
SB-4 10-12'	80											
SB-4 15-17'												
SB-5 0-2	90											
SB-5 5-7	100											
SB-5 10-12												
SB-5 15-17												
~~[illegible]~~												
SB-6 5-7	110											
SB-6 10-12	120											

SPECIAL INSTRUCTIONS:

Items/Reason	Relinquished By	Received By	Date	Time	Items/Reason	Relinquished By	Received By	Date	Time
Samples	J.A. Williams	Victoria K. Dolan	3/1/85	1035					

H-1

191

WESTON

Custody Transfer Record/Lab Work Request

Received By ______ Client USAF Meguire AFB RFW Contact R. Johnson
Date ______ Client Contact ______ Date Due ______
Assigned to ______ Phone ______ Project Number 0628 0903

8503-287-

SAMPLE IDENTIFICATION					ANALYSES REQUESTED							
Sample No.	Client ID No.	Description	Date Collected	Container/Preservative	O/G BY IR							
SB-6 15-17'		Soil Samples										
SB-7 5-7'	0130	—										
SB-7 10-12'												
SB-7 12-14'			6 March 85									
SB-8 7-9'	0140	—	7 March 85									
SB-8 9-11'												
SB-8 11-13'												
SB-10 5-7'	0150	—										
B-11 Composite	160	—										
B-12 Composite	170	—										
B-13 Composite 0-12'	180	—										
B-13 11-13'			7 March 85									
'												

SPECIAL INSTRUCTIONS:

Items/Reason	Relinquished By	Received By	Date	Time	Items/Reason	Relinquished By	Received By	Date	Time
Sampler	J.A. Williams	Victor [illegible]	3/11/85	1035					

WESTON

Custody Transfer Record/Lab Work Request

Received By ______ Client USAF McGuire RFW Contact R JOHNSON

Date ______ Client Contact ______ Date Due ______

Assigned to ______ Phone ______ Project Number 0628 09 03

803-287-

SAMPLE IDENTIFICATION					ANALYSES REQUESTED							
Sample No.	Client ID No.	Description	Date Collected	Container/Preservative	H-NU (ppm)		O/G by IR					
B-14 0-11	0190	Soil	9 March 85		10							
B 14 11-13	200				50							
~~215~~												
B15 11-13	210				40							
B16 0-13	220				1							
B17 0-13	230				0.6							
B18 0-2	240				42							
B18 5-13	250		8 March 85		0							
B19 0-13	260				0.2							
B20 0-13	270				0.4							
B21 0-11	280				0							
B22 0-11	290				0.3							
B23 0-11	300				0.4							

SPECIAL INSTRUCTIONS:

Items/Reason	Relinquished By	Received By	Date	Time	Items/Reason	Relinquished By	Received By	Date	Time
Samples	J A Williams	Patrick [illegible]	[illegible] 85	1035					

WESTON

Custody Transfer Record/Lab Work Request

Received By ______ Client USAF McGuire RFW Contact R JOHNSON
Date ______ Client Contact ______ AFB Date Due ______
Assigned to ______ Phone ______ Project Number ______

825-257-

Sample No.	Client ID No.	Description	Date Collected	Container/Preservative	PPM HNU		O/G By IR					
SB25 0-2'		Soil	3/--/85		4							
SB25 5-7'	0310	"			11							
SB25 7-9'					50							
SB25 9-11	0320	"			35							
25 11-13					45							
B25 13-15					60							
B26 0-2					0.5							
B26-5-7	0330	"			5							
B26 7-9'					8.5							
B26 9-11	0340	"			60							
B26 11-13					55							
B26 13-15					70							
B24 0-2					60							
B24 5-7					8							
B24 7-9	0350	"			40							
B24 9-11					48							
B24 11-13	0360	"			5							
B27 0-2	370	"			0.2							
B27 11-13	380	"			2.8							
SB28 0-11'	390	"										

SPECIAL INSTRUCTIONS:

JAR Reading

Items/Reason	Relinquished By	Received By	Date	Time	Items/Reason	Relinquished By	Received By	Date	Time
Samples	J.A. Williams	[signature]	3/11/85	1055					

WESTON

8323-287

Custody Transfer Record/Lab Work Request

Received By ______ Client USAF McGuire AFB RFW Contact R. Johnson

Date ______ Client Contact ______ Date Due ______

Assigned to ______ Phone ______ Project Number 06280903

SAMPLE IDENTIFICATION					ANALYSES REQUESTED							
Sample No.	Client ID No.	Description	Date Collected	Container/Preservative	O/G							
SB-29 5-7'	0400	Soils	3/8/85									
SB-29 7-8'												
SB-29 8-9'	0410											
SB-29 11-13'												
SB-30 0-11'	0420											
SB-30 11-13'	0430											

SPECIAL INSTRUCTIONS:

Items/Reason	Relinquished By	Received By	Date	Time	Items/Reason	Relinquished By	Received By	Date	Time
Samples	J.A. Williams	[illegible]	1055	3/11/85					

WESTON
003

Custody Transfer Record/Lab Work Request

Received By E. Cartwell — Client USAF McGuire — RFW Contact R. Johnson
Date 19 March 85 — Client Contact — Date Due
Assigned to — Phone — Project Number 0628-09-03

→ 8503-F11-

SAMPLE IDENTIFICATION					ANALYSES REQUESTED							
Sample No.	Client ID No.	Description	Date Collected	Container/Preservative	[illegible]	IR						
-0010		MW TF 18 (14'-21')	11 March	Brown glass	hold							
-0020		Soil TF 19 (8'-20')	11 March		hold							
-0030		TF 20 (5'-15')	12 March		✓							
-0040		TF 21 (15'-22')	12 March		hold							
-0050		TF 22 (15'-20')	12 March		hold							
-0060		TF 23 (5'-22')	13 March		✓							
-0070		TF24 (10'-20')	13 March		hold							
-0080		TF 24 (23'-25')	13 March		hold							

SPECIAL INSTRUCTIONS (6) samples on hold, [illegible] or R. Johnson will call

Items/Reason	Relinquished By	Received By	Date	Time	Items/Reason	Relinquished By	Received By	Date	Time
Bio/Hazard	[illegible]	C.C. [illegible]	3/19	1424					

H-6

WESTON

Custody Transfer Record/Lab Work Request

Received By
Date 5 April 85
Assigned to

Client Mcguire AFB
Client Contact
Phone

RFW Contact R. Johnson
Date Due
Project Number 0527-09-03

OCH2

SAMPLE IDENTIFICATION					ANALYSES REQUESTED							
Sample No.	Client ID No.	Description	Date Collected	Container/Preservative	Oil & Grease	by IR						
		1b Surface Soils	3/24/85	100ml Amber Cool								
		2b										
		3b										
		4b										
		5b										
		6b										
		7b										
		8b										
		9b										
		10b										
		11b										
		12b										
		13b										
		14b										
		15b										
		16b										

SPECIAL INSTRUCTIONS

Items/Reason	Relinquished By	Received By	Date	Time	Items/Reason	Relinquished By	Received By	Date	Time

WESTON

Custody Transfer Record/Lab Work Request

Received By ______ Client McGuire AFB RFW Contact Surface WATER
Date 4/April 85 Client Contact ______ Date Due ______
Assigned to ______ Phone ______ Project Number ______

SAMPLE IDENTIFICATION					ANALYSES REQUESTED
Sample No.	Client ID No.	Description	Date Collected	Container/Preservative	
		OIL & GREASE IR		[illegible]/ H_2SO_4	✓
		~~[illegible]~~	3 April 85		
		FIELD [illegible] BLANK	3 April		
		TRIP BLANK	3 April		
		STA 1 UP	4 April		
		STA 2 Down	4 April		

SPECIAL INSTRUCTIONS:

Items/Reason	Relinquished By	Received By	Date	Time	Items/Reason	Relinquished By	Received By	Date	Time

Custody Transfer Record/Lab Work Request

Client McGuire A.F.B

Client Contact

Phone

RFW Contact SURFACE WATER

Date Due

Project Number

SAMPLE IDENTIFICATION

ANALYSES REQUESTED

[illegible]	[illegible]	Description	Date Collected	Container/Preservative	BTX							
[illegible]	[illegible]	ANALYSIS		40 ml								
[illegible]	[illegible]	[illegible]	3 April 85									
[illegible]	[illegible]	[illegible]	[illegible]									
[illegible]	[illegible]	[illegible]	[illegible]									
[illegible]	[illegible]	[illegible]	[illegible]									
[illegible]	[illegible]	[illegible]	[illegible]									

SPECIAL INSTRUCTIONS

Items/Reason	Relinquished By	Received By	Date	Time	Items/Reason	Relinquished By	Received By	Date	Time
	[illegible]								
	[illegible]								

WESTON

Custody Transfer Record/Lab Work Request

Received By ____________________
Date 4 April 85
[illegible] ____________________

Client MCGUIRE AFB
Client Contact ____________________
Phone ____________________

RFW Contact ____________________
Date Due ____________________
Project Number ____________________

SAMPLE IDENTIFICATION

ANALYSES REQUESTED

[illegible]	[illegible]	Description	Date Collected	Container/Preservative		BTX						
		EPA 601 602	3 Apr 85	40 ml								
		7E 18A										
		19A										
		20A										
		21A										
		22A										
		23A										
		24A										
		25A										
		25C										

SPECIAL INSTRUCTIONS:

Items/Reason	Relinquished By	Received By	Date	Time	Items/Reason	Relinquished By	Received By	Date	Time
[illegible]	[illegible]								
	[illegible signature]								

WESTON

OEHL

Custody Transfer Record/Lab Work Request

Received By	Client Mc Guire A.F.B.	RFW Contact Judy [illegible]
Date [illegible]	Client Contact Rich Johnson	Date Due
Assigned to	Phone	Project Number

SAMPLE IDENTIFICATION — **ANALYSES REQUESTED**

Sample No.	Client ID No.	Description	Date Collected	Container/Preservative	Preserved H_2SO_4	OG → IR						
		Oil + Grease By IR	3 April 85	1000 ml Amber glass	✓							
		WATER [illegible]										
		[illegible]										
		[illegible]										
		[illegible]										
		[illegible]										
		[illegible]										
		[illegible]										
		[illegible]										

SPECIAL INSTRUCTIONS

Items/Reason	Relinquished By	Received By	Date	Time	Items/Reason	Relinquished By	Received By	Date	Time
Bottles listed	[illegible]								

WESTON

sent 2/26

Custody Transfer Record/Lab Work Request

Received By ____ Client Mc Guire AFB RFW Contact Judy Porter ~~Rich Johnson~~

Date ____ Client Contact ____ Date Due ____

Assigned to ____ Phone ____ Project Number 0628-09-03

SAMPLE IDENTIFICATION / ANALYSES REQUESTED

Sample No.	Client ID No.	Description	Date Collected	Container/Preservative	O/G by IR							
		WELL MW-12 A	24 April 85	1000ML AMBER / H_2SO_4								
		WELL MW-13	"									
		WELL 18	"									
		19	23									
		20	24									
		21	23									
		22	24									
		23										
		24										
		25										

SPECIAL INSTRUCTIONS:

Items/Reason	Relinquished By	Received By	Date	Time	Items/Reason	Relinquished By	Received By	Date	Time
Groundwater	Judith Jordan								

WESTON

Due 4/24

Custody Transfer Record/Lab Work Request

Received By ______ Client USAF/Akbuire AFB RFW Contact Judy Serta

Date ______ Client Contact ______ Date Due ______

Assigned to ______ Phone ______ Project Number [redacted]

SAMPLE IDENTIFICATION					ANALYSES REQUESTED							
Sample No.	Client ID No.	Description	Date Collected	Container/Preservative	O/G by IR							
		WELL 20 BLANK A		1000 ml Amber / H_2SO_4	↓							
		WELL 20 [redacted] Dup. A		" / "	↓							

SPECIAL INSTRUCTIONS:

Items/Reason	Relinquished By	Received By	Date	Time	Items/Reason	Relinquished By	Received By	Date	Time
Groundwater	Judith Serley								

WESTON

Custody Transfer Record/Lab Work Request

Received By ____________ Client *USAF/McGuire AFB* RFW Contact *Judy Porter*

Date ____________ Client Contact ____________ Date Due ____________

Assigned to ____________ Phone ____________ Project Number ____________

Sent 4/26

SAMPLE IDENTIFICATION					ANALYSES REQUESTED							
Sample No.	Client ID No.	Description	Date Collected	Container/Preservative	*BTX*	*by 602*	[illegible])					
		MW-13 A	*24 April 85*	*40ml vial/cool*								
		MW-12 A	*"*	*(2 per set)*								
		WELL 18 A	*"*									
		19	*23*									
		20	*24*									
		21	*23*									
		22	*24*									
		23										
		24										
		25										

SPECIAL INSTRUCTIONS:

Items/Reason	Relinquished By	Received By	Date	Time	Items/Reason	Relinquished By	Received By	Date	Time
Groundwater	*Judith Porter*								

WESTON

Custody Transfer Record/Lab Work Request

Received By ______ Client USAF/McClure AFB RFW Contact ______

Date ______ Client Contact ______ Date Due ______

Assigned to ______ Phone ______ Project Number ______

Snt 4/28

SAMPLE IDENTIFICATION					ANALYSES REQUESTED							
Sample No.	Client ID No.	Description	Date Collected	Container/Preservative	BTX by GC			[redacted]				
		WELL 20 BLANK A	21 April '85	40 ml vial/cool	↓							
		WELL 20 [redacted] Dup A	" ↓ ↓	(2 per set)	↓							
		TRIP BLANK A	22	↓	↓							

SPECIAL INSTRUCTIONS:

Items/Reason	Relinquished By	Received By	Date	Time	Items/Reason	Relinquished By	Received By	Date	Time
Groundwater	[illegible]								

DAT
FILM
5

WESTON

Sample No.	Cl

SPECIAL INSTRUCT

Items/Reason

WEST

Sample No.

SPECIAL INS

Name/Reaso

WESTON

Sample No.

SPECIAL INSTRUC

Items/Reason